SCHOOL OF CIVIL ENGINEERING

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ENGINEERING SOILS MAP OF HENRY COUNTY, INDIANA FINAL REPORT

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PURDUE UNIVERSITY

Final Report
ENGINEERING SOILS MAP OF HENRY COUNTY, INDIANA

TO:	H. L. Michael, Director Joint Highway Research Project	26 April 1990 Project: C-36-51B File: 1-5-2-87
FROM:	C. W. Lovell, Research Engineer Joint Highway Research Project	

The attached report entitled "Engineering Soils Map of Henry County, Indiana," completes a portion of the long-term project concerned with the development of county engineering soils maps of the 92 counties in the State of Indiana. This report, the 87th report of the series, was prepared by Barbara I. Schmidt, Research Assistant, Joint Highway Research Project, under the direction of myself and Professor Emeritus, R. D. Miles.

The soils mapping of Henry County was done primarily by the analysis of landforms and associated parent materials as portrayed on stereoscopic aerial photographs. Valuable information for soils was obtained from publications of the Soil Conservation Service, United States Department of Agriculture. Test data from roadway and bridge projects was obtained from the Indiana Department of Transportation. Soil profiles for the landform/parent material areas mapped are presented on the engineering soils map, a copy of which is included at the end of the report.

Respectfully submitted,

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FINAL REPORT

ENGINEERING SOILS MAP OF HENRY COUNTY, INDIANA

by

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Research Assistant

Joint Highway Research Project

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Thank you's go to Mei Zhang for her patience and skill in drafting the map and figures, to Cheryl Burroughs and Rita Pritchett for help in preparing tables and for typing the classification test results included in Appendix A of this report, and to Mary Lundstrom for her critical review of this manuscript.

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ABSTRACT

Engineering soils maps are maps which display the distribution and types of landforms and parent materials encountered in specified areas. Knowledge of these parameters gives the design professional a general idea of the behavior to be expected from the soils derived from it.

In Henry County, the five mapped parent material units are glacial drift, cumulose drift, glacial-fluvial drift, alluvial drift, and mined lands. In glacial drift, the mapped landforms are ridge moraine and ground moraine, while in cumulose drift, the mapped landforms are muck basins. Landforms common to glacial-fluvial drift are outwash plains, kames and eskers, glacial sluiceways, and terraces. Flood plains are the landforms found in alluvial drift areas, and in mined lands, gravel pits are the landforms encountered.

As landform-parent material regions vary, so do the accompanying engineering problems. General engineering concerns include ponded water and the related problems of frost action, difficulties in locating septic or other sanitary disposal facilities, and overall utility of the land. Concerns are also raised for organic-rich, low or highly varying material strength which contribute to the potential for differential settlement, problems in delineating acceptable foundation locations, and additional project cost from removal and replacement of unsuitable materials. Additional concerns include locating adequate supplies of coarse-grained building materials, securing reliable water sources, corrosion potential of soils, and permeabilities of soils.

ENGINEERING SOILS MAP
OF
HENRY COUNTY, INDIANA

INTRODUCTION

The engineering soils map of Henry County, Indiana, which accompanies this report as Plate 1, was prepared through airphoto interpretation techniques using accepted principles of observation and inference. One set of seven inch by nine inch aerial photographs used in this study had an approximate scale ratio of 1:20000 and were taken in June/July 1940 by the United States Department of Agriculture. A second set of nine inch by nine inch aerial photographs used had an approximate scale ratio of 1:24000 and were taken in March 1976. The enclosed engineering soils map (Plate 1) was prepared at a scale of 1:63,360 (one inch equals one mile).

Extensive use was made of the 1987 Agricultural Soil Survey for Henry County (1). The survey was particularly useful in cross-referencing the location of the various boundaries, and in locating features not present on the earlier photos. Also, a reconnaissance field trip was made to the county.

Included on the map is a set of subsurface profiles which illustrate approximate variations to be expected in the general soil profiles of the major soils of each landform-parent material region. The profiles were developed from information contained in the agricultural soil survey report and from borehole data collected for roadway and bridge site investigations (49-64). Boring locations are shown on Plate 1; Appendix A contains a summary of classification test results for these locations.

Included in this report are general descriptions of the study area, descriptions of the geology of Henry County, descriptions of the various landform-parent material regions, and a discussion of the engineering considerations associated with the soils of Henry County.

The map and report are part of a continuing effort to complete a comprehensive engineering soil survey for the State of Indiana. Therefore, the continuity of soil boundaries was carefully checked at the borders with the previously mapped Delaware (2), Fayette (3), Hancock (4), Madison (5), and Rush (6) counties.

This close examination revealed discrepancies across the borders with Delaware and Rush Counties. The discontinuity of landforms with Delaware County was resolved by rechecking the airphotos used to prepare the Delaware County map (2). It was discovered that an area mapped as ridge moraine was mistakenly labeled as outwash plain. The misnomer covered only a small area near State Road 3; thus a revised map will not be issued.

The boundary with Delaware County was further complicated by problems stemming from distortions in the base map for the area. The distortion resulted in sections, normally one square mile in area, which were less than one square mile. Accumulation of these errors netted a mismatch of nearly one half mile. Attempts were made to evenly distribute the error, but the user is cautioned about use of the spatial information of this boundary.

The airphotos used to map the engineering soils of Rush County were reexamined in hopes of discovering the error source. Unfortunately, the original markings had been removed. It was determined, however, that a change in standard symbology in the year 1953 added to the problem. Consequently, a revised map for Rush County will be issued in the future.

DESCRIPTION OF THE AREA

GENERAL

Henry County is located in east-central Indiana, as shown in Figure 1. The county is bounded to the north by Delaware County, to the east by Randolph and Wayne Counties, to the south by Fayette and Rush Counties, and to the west by Hancock and Madison Counties. Henry County covers an area of 252,499 acres, or about 395 square miles (1). New Castle, the county

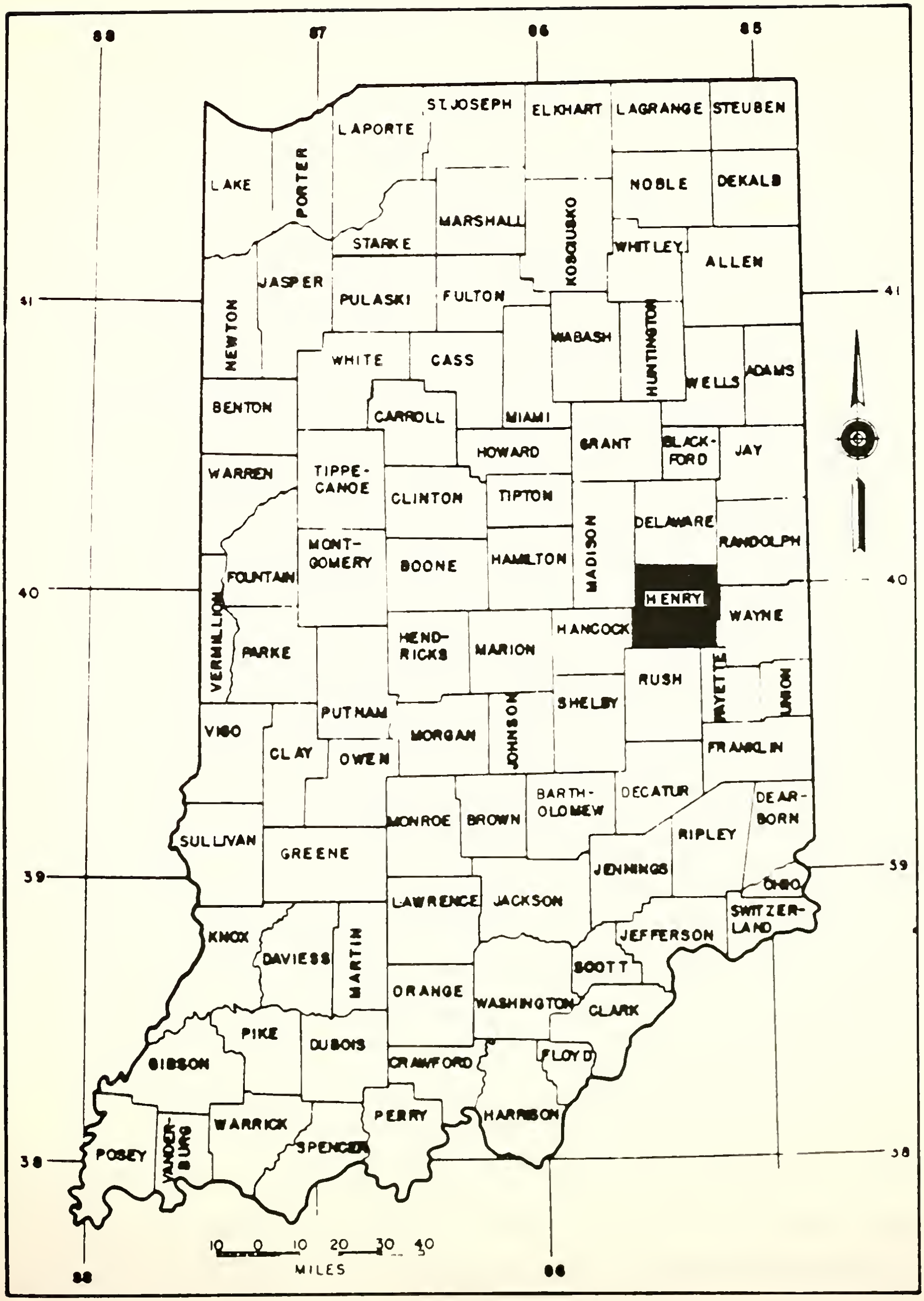


Figure 1 LOCATION OF HENRY COUNTY, INDIANA

seat, is located in the center of the nearly square shaped county and is approximately 50 miles east of Indianapolis. Organized in 1822, Henry County is named in honor of American patriot Patrick Henry.

Henry County, according to the 1980 census, has a population of 53,336 which is a 1.39% increase in population from 1970 (7). The population of the cities and towns in the county accounts for 0.97% of the state population and is summarized in Table 1.

The residents of Henry County are employed in New Castle and surrounding counties or are in farming. Nearly 70% of the acreage in the county is farmed, with the principal crops being corn, soybeans, and wheat. There are also several orchards in the county (1).

The county contains several major roadways, namely I-70, US 35, US 36, SR 3, and SR 38. The county is served by an extensive county road system, but a large percentage of the roads are gravel surfaced. Three main railways traverse the county (1).

CLIMATE

The following generalities concerning climate in Henry County can be found in the Agricultural Soil Survey (1).

The lowest temperature recorded, -28 degrees F, occurred on 29 January 1963, while the highest recorded temperature, 102 degrees F, occurred on 29 July 1952. The average annual precipitation is 40 inches, 58% of which falls in the months of April through September. The average seasonal snowfall is nearly 22 inches. Thunderstorms occur on about 45 days a year, mostly in the spring, coincident with the occurrence of the strongest winds, which blow at an average speed of 12 miles per hour from the southwest. The sun shines nearly 70% of the possible time in the summer, and nearly 40% of the time possible in the winter.

Table 2 presents average maximum and minimum temperatures and average precipitation amounts for the period 1980-1988. The data in this table were calculated by arithmetically averaging the recorded monthly data collected at a station in New Castle. The thirty year normal

Table 1 Population Trends of Henry County (7).

City/Town	Population		Population Change	
	1980	1970	Difference	% Change
Blountsville	213	220	-7	-3.18
Cadiz	180	207	-27	-13.04
Dunreith	184	200	-16	-8.00
Greensboro	175	225	-50	-22.22
Kennard	441	518	-77	-14.86
Knightstown	2,325	2,456	-131	-5.33
Lewisville	577	530	47	8.87
Middletown	2,978	2,046	932	45.55
Moreland	479	495	-16	-3.23
Mt. Summit	357	395	-38	-9.62
New Castle	20,056	21,215	-1,159	-5.46
Spiceland	940	957	-17	-1.78
Springport	221	236	-15	-6.36
Straughn	331	329	2	0.61
Sulphur Springs	345	387	-42	-10.85
Cities/Towns	29,802	30,416	-614	-2.02
Rural Areas	23,534	22,187	1,347	6.07
County Total	53,336	52,603	733	1.39

Table 2 Temperature and Precipitation for 1980-1988 (8).

Month	Average Temperature (degrees Farenheit)			Average Precipitation (inches)
	Maximum	Minimum	Average	
January	32.0	15.5	23.8	1.45
February	37.5	19.0	28.3	2.21
March	48.4	28.0	38.2	2.82
April	61.2	37.9	49.6	3.23
May	73.3	49.1	61.2	4.82
June	82.1	57.8	69.9	3.57
July	85.7	63.0	74.4	5.27
August	84.0	60.9	72.5	2.85
September	77.3	53.0	65.2	2.18
October	63.4	41.2	52.3	3.52
November	51.6	32.8	42.2	3.99
December	38.2	22.2	30.2	2.93
Annual	58.6	40.0	50.7	38.84

values, also collected in New Castle, are commonly used for comparison to recent climatic events, and are given in Table 3 for the years 1951-1980.

DRAINAGE FEATURES

Henry County lies within three major drainage basins, as shown in Figure 2. The majority of the county lies within the East Fork White River Basin, but the easternmost and northern sections lie in the Whitewater River and White River Basins, respectively. The drainage map of Henry County is shown in Figure 3.

The upper portion of the East Fork of the White River Basin displays a well developed sub-parallel drainage pattern (12). The average stream direction is S27(deg)W, and two-thirds of all stream segments are oriented in the range S1E to S55W, that is, within 28 degrees of the mean direction (12). Some waterways contained in this basin are, from west to east, Montgomery Creek, Big Blue River, Buck Creek, Little Blue River, and Flatrock River. In the northernmost reach of the basin, many infiltration basins can be found, thus indicating a more coarse texture of the soil (11).

The streams of the White River Basin to the north include, from west to east, Fall, Mud, Deer, Sugar, Honey, and Bell creeks. The streams of the Whitewater Basin to the east, include Roy Run and Simon Creek.

Many man-made channels augment the drainage features found naturally. These channels are typically located in soils which have a tendency to pond such as Westland, Treaty, Martsico, and Cyclone, which are contained in areas of ground moraine, highly organic and mucky areas, and to a lesser extent, ridge moraine. Small bodies of water can also be found in the areas prone to ponding.

The county has some larger perennial lakes such as Summit Lake, Westwood Lake, and Knightstown Lake, but contains no large natural lakes. Many borrow pits, excavated for highway fill but now filled with water, and farm ponds dot the Henry County landscape.

Table 3 Thirty-Year Normals for Temperature and Precipitation (9).

Month	Average Temperature (degrees Farenheit)			Average Precipitation (inches)
	Maximum	Minimum	Average	
January	33.8	15.6	24.7	2.45
February	37.2	18.0	27.7	2.23
March	47.7	27.7	37.7	3.27
April	61.3	38.2	49.8	4.19
May	72.4	48.2	60.3	4.06
June	81.8	57.9	69.9	4.39
July	85.5	61.2	73.4	3.84
August	83.8	58.8	71.3	3.62
September	77.6	51.5	64.6	2.62
October	65.4	39.9	52.7	2.66
November	50.4	30.7	40.5	3.00
December	38.6	21.4	30.0	2.64
Annual	61.3	39.1	50.2	38.97

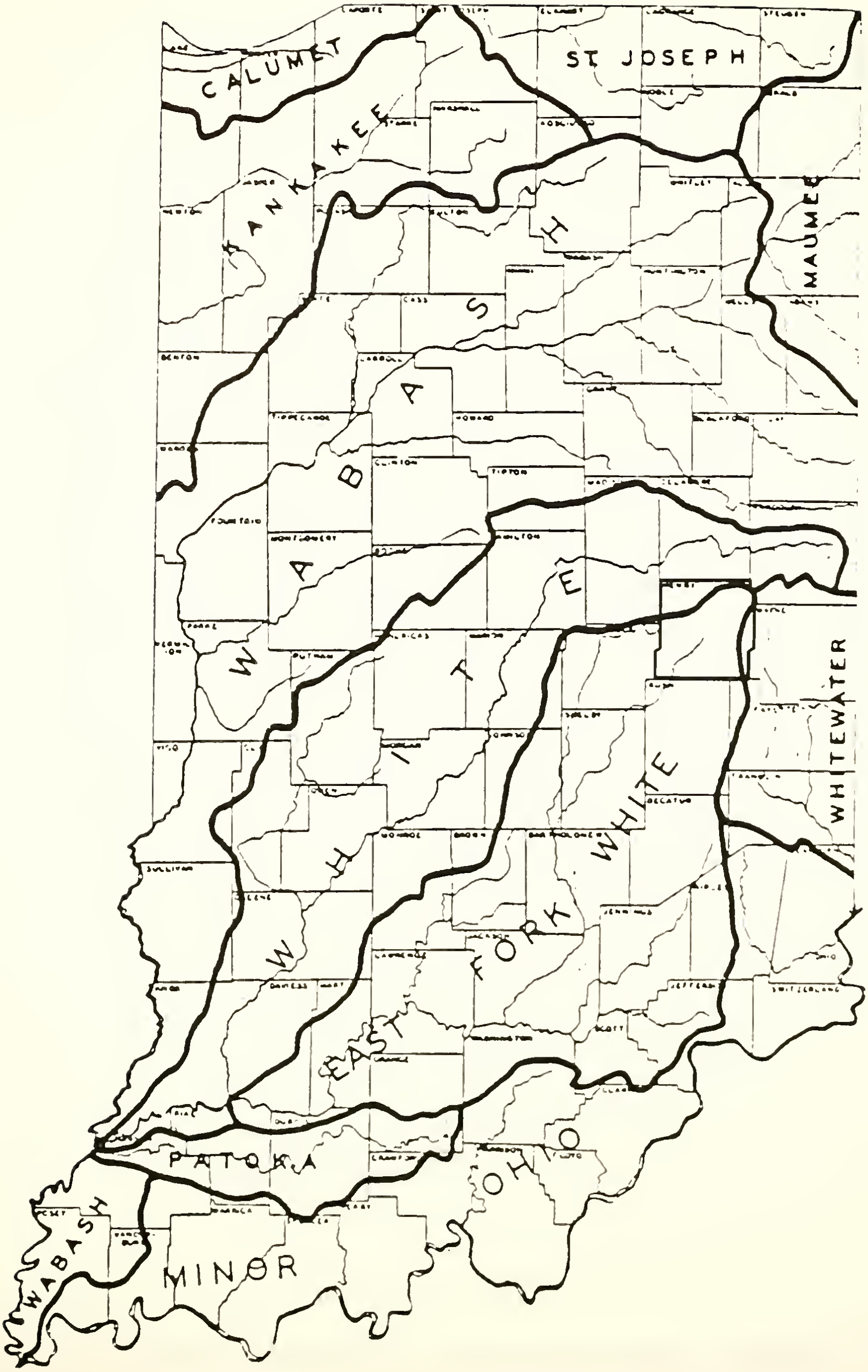


Figure 2 MAJOR WATERSHEDS OF INDIANA (10).

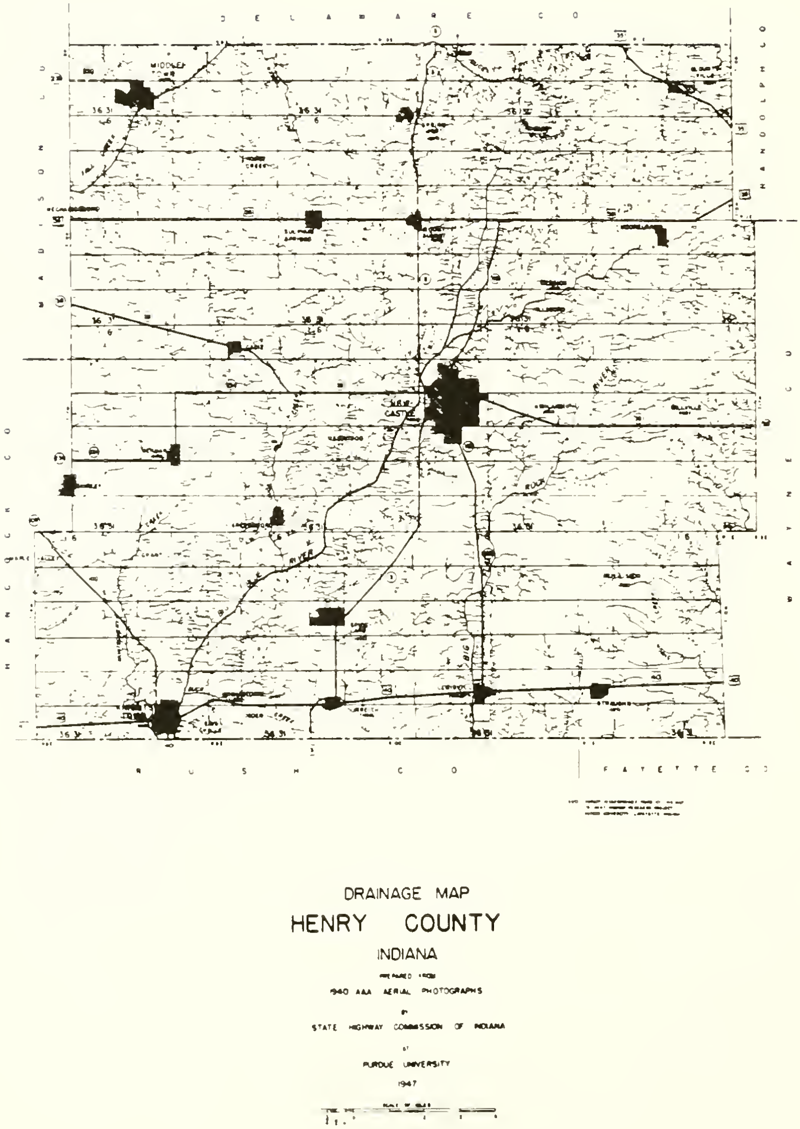


FIGURE 3 DRAINAGE MAP OF HENRY COUNTY (11).

Drainage density is a measure of stream length to contributing basin area. The values given in Table 4 were taken from a map supplied by the Indiana Department of Natural Resources, Division of Water (13).

An analysis of streamflow data for Sugar Creek near Middletown is given in Appendix B. Included in this appendix are records of daily mean discharges, highest and lowest mean discharges and related rankings, normal monthly means, annual mean discharges, exceedence probabilities, and a station location description (14).

WATER SUPPLY

The water resources of the county are used for domestic, industrial, and agricultural purposes. Henry County is located in the Southern Till Plain Groundwater Section of the Northern Indiana Glacial Province, as shown in Figure 4. The water use in Henry County for 1988 is summarized in Table 5. A total of 1832.94 million gallons (MG) were used, with 1520.22 MG from ground water sources and 312.72 MG from surface water sources (15). Table 6 is a breakdown of water usage by source and basin.

As indicated by both tables, Henry County relies upon groundwater sources more than surface water sources. For 1988, approximately 75% of all water used in the county was for public water supply and was taken from groundwater sources (15).

Figure 5 is a map of typical yields available from groundwater. The small flagellate area in the center of the county represents a potentially rich water source. Here, most wells penetrate sand and gravel deposits, and range from 50 to over 170 feet in depth. Wells commonly exceed 1000 gallons per minute (gpm) in production. (16)

The large area in the western portion of the county exhibits wells in both bedrock and sand and gravel deposits; both are reliable for moderate production, but wells completed in sand and gravel are the higher yielding. Wells range from 30 to over 150 feet in depth. Production of up to 250 gpm in sand and gravel and 150 gpm in bedrock wells is common. The yields from

Table 4 Drainage Densities for Selected Streams (13).

Stream and Location	Area (sq. mi)	Drainage Density (mi/sq. mi)
Big Blue R above Sheets D	8.90	4.78
Big Blue R above Little Blue R	23.72	5.04
Central Ck at mouth	3.86	3.49
Deer Ck at mouth	7.12	4.52
Duck Ck above Jakes Br	9.28	2.59
Fall Ck at C.R. 950N	4.95	4.24
Honey Ck at mouth	7.37	2.49
Jakes Br at mouth	4.73	3.88
Simon Ck above Roy Run	15.60	2.46
Montgomery Ck above Central Ck	16.00	3.00
Montgomery Ck	24.29	3.20
Duck Ck	27.31	3.48

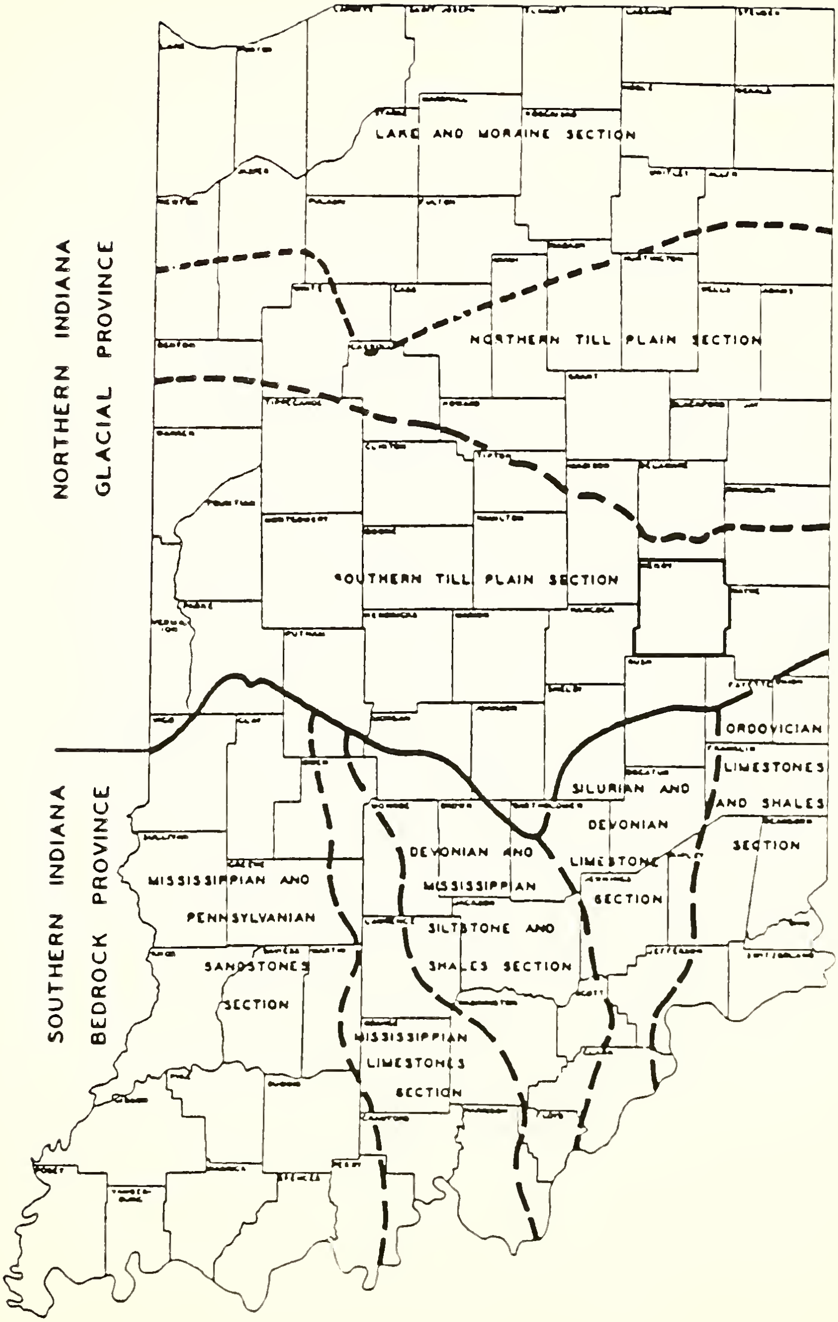


Figure 4 GROUNDWATER SECTIONS OF INDIANA (10).

Table 5 County Water Use in Millions of Gallons (15).

Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Ground	102.65	107.23	110.63	101.49	115.79	123.67	152.96	162.33	139.74	138.75	129.42	132.58	1520 22
Surface	18.77	18.77	18.77	23.97	30.25	29.66	35.60	35.10	31.48	21.37	28.73	20.25	312.72
Total	121.42	126.00	129.40	128.46	146.04	153.33	188.50	197.44	171.23	160.12	158.15	152.82	1832.94

Table 6 Water Use for Henry County by Basin (15).

Source	White and West Fork White Rivers	East Fork White River	Whitewater River	Total
Ground	162.75	1298.26	59.21	1520.22
Surface	73.80	238.93	--	312.73
Total	236.55	1537.19	59.21	1832.95

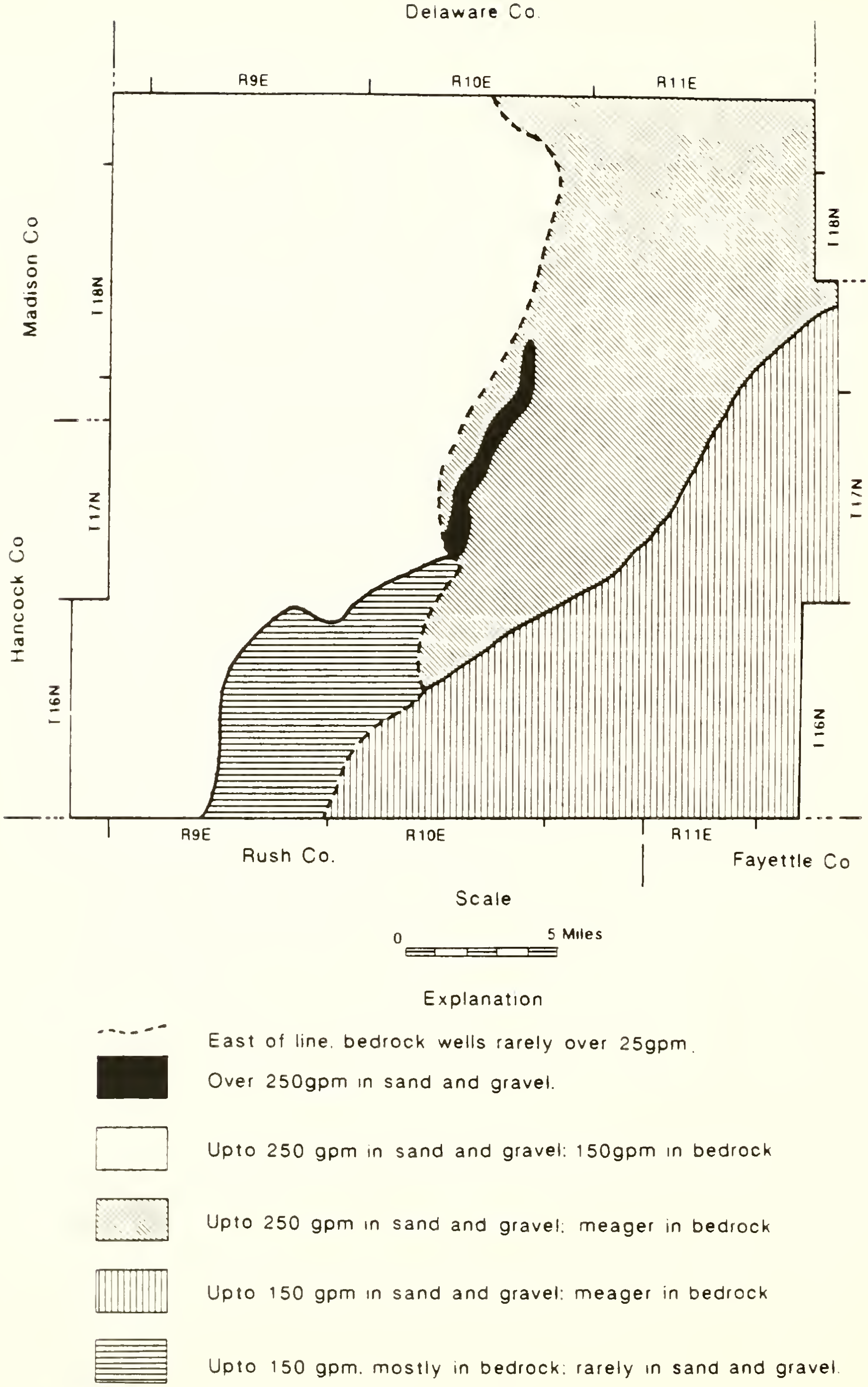


Figure 5 Typical Yields of Ground Water in Henry County (16)

bedrock are highest where the bedrock is less than 100 feet from the surface and overlain by sand and gravel. As the depth to bedrock increases, or where covered by glacial till, the yields from bedrock wells fall (16).

The area to the northeast is mainly served by sand and gravel based wells. Well depths range from 25 to 250 feet, and yields are up to 250 gpm in sand and gravel. As expected, wells in this area, east of the dashed line on Figure 5, support little bedrock well production (16).

The area in the southeast also has little production from bedrock wells, but wells producing up to 150 gpm are located in sand and gravel deposits. The production of wells is so diminished that many "dry holes" have been recorded. Average well depth is between 100 and 150 feet (16).

The fifth area, represented by horizontal lines on Figure 5, reliably supports well production in the generally shallow limestone bedrock. The wells range in depth from 25 to over 200 feet and yields of up to 150 gpm may be developed (16).

As shown in Figure 6, Henry County is underlain by Devonian, Silurian, Ordovician, and Cambrian water-bearing strata. The Silurian bedrock, which thins to the east, provides a reliable source of water for the western fourth of the county. The bedrock is mainly limestone and dolomite, with zones of shale which become predominant toward the east. The underlying Ordovician rocks are infrequently a potable source as they contain mineralized water, especially below a depth of 300 feet. Deeper water-bearing strata include Trenton and Black River limestones, St. Peter and Mt. Simon sandstones, and the Knox Dolomite (16).

PHYSIOGRAPHY

Henry County lies in the Central Till Plains Section of the Central, Arctic, and Eastern Lowlands and Plains Province of the United States (18). Within Indiana, as shown in Figure 7, Henry County is located within the Tipton Till Plains Subsection of the Central Till Plains Section (19).

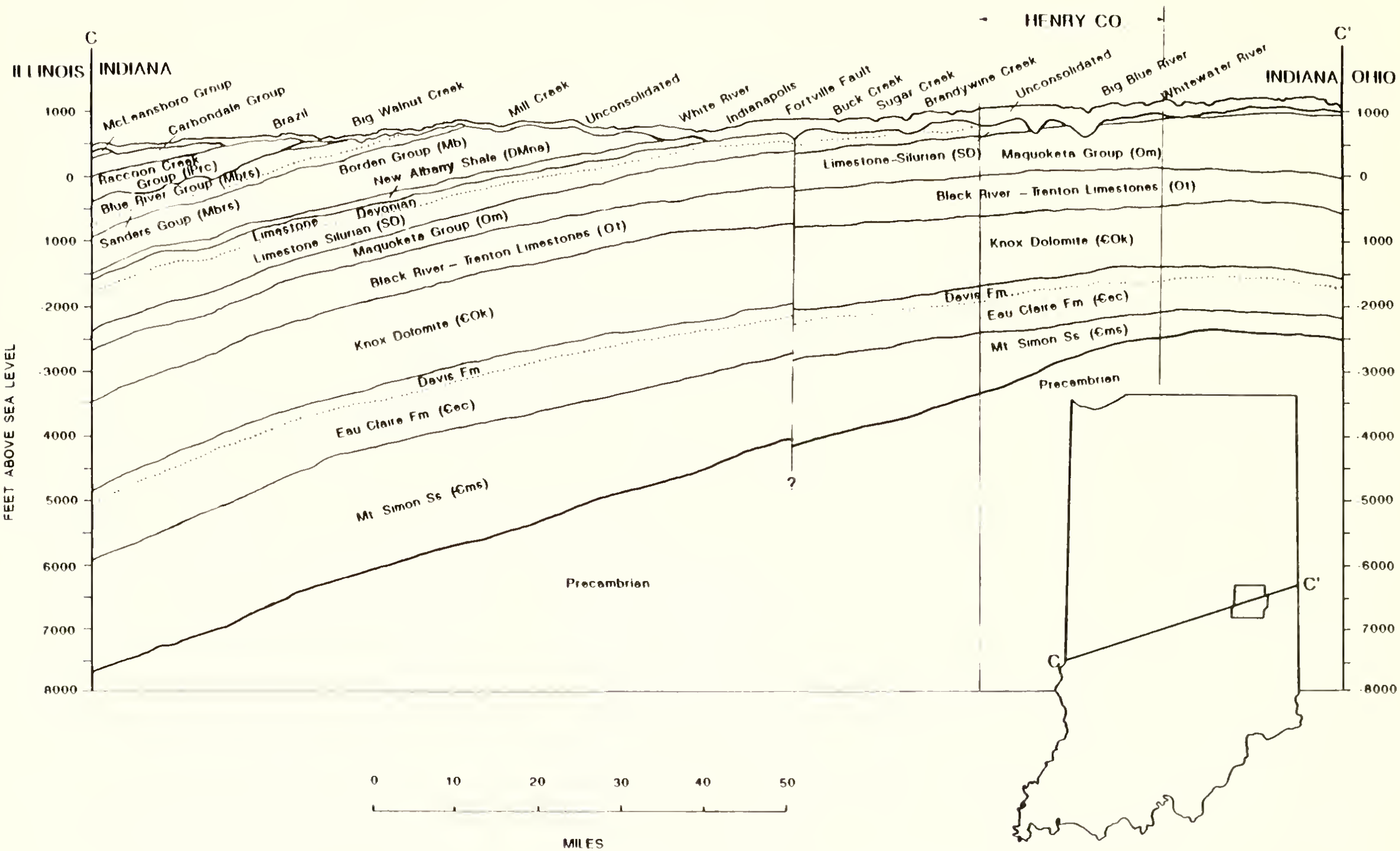


FIGURE 6 HYDROSTRATIGRAPHIC CROSS SECTION OF INDIANA WITH EMPHASIS ON HENRY COUNTY (17).

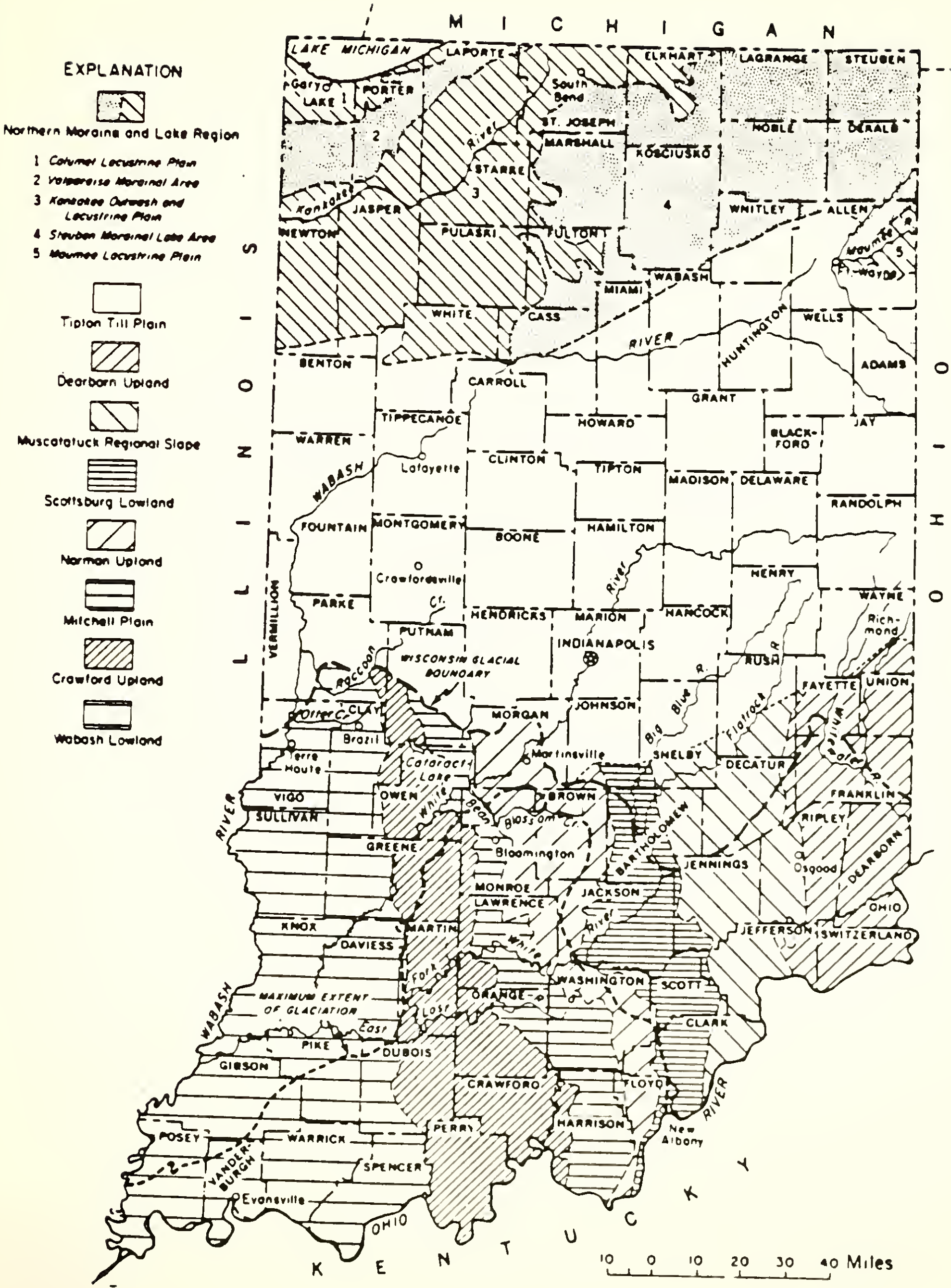


FIGURE 7 PHYSIOGRAPHIC UNITS AND GLACIAL BOUNDARIES OF INDIANA (19)

TOPOGRAPHY

From the low-lying areas in the southwestern part to the higher and more rugged surface of the northeastern part, the topography of Henry County reflects its glacial origins. The present-day Big Blue and Flatrock Rivers follow the course of Pleistocene meltwaters which carved their valleys, and rolling topography encountered in much of the county results from a cover of granular moraine.

The valleys of the Big Blue and the Flatrock are, in places, one half mile wide and 40 to 60 feet deep into the surrounding till tract (20). Post-Pleistocene waters have changed the character of these valleys very little. In the morainic areas, the local relief is very slight, but around Mt. Summit, there is an abrupt rise of nearly 75 to 100 feet over the surrounding land (20). Scattered kames and eskers provide additional areas of high relief, but the remainder of the county varies from gently undulating to monotonously flat ground moraine (20).

Figure 8 is a topographic map of Henry County. It was prepared from the Cincinnati and Muncie one degree by two degree USGS topographic maps. The two maps had different contour intervals; thus to provide a uniform map, linear interpolation from 7.5 minute USGS topographic maps (23-34) was performed.

The lowest elevations encountered, under 900 feet, are those in the Big Blue River valley near Knightstown, while the highest, over 1150 feet, occur in the northeastern corner near the boundary with Randolph and Wayne Counties. The maximum relief is 270 feet, and the average elevation is 1040 feet (35).

GEOLOGY OF HENRY COUNTY

The surface and near-surface deposits of Henry County range from bedrock of the Paleozoic Era to unconsolidated deposits of the Quaternary Period. The bedrock is composed chiefly of

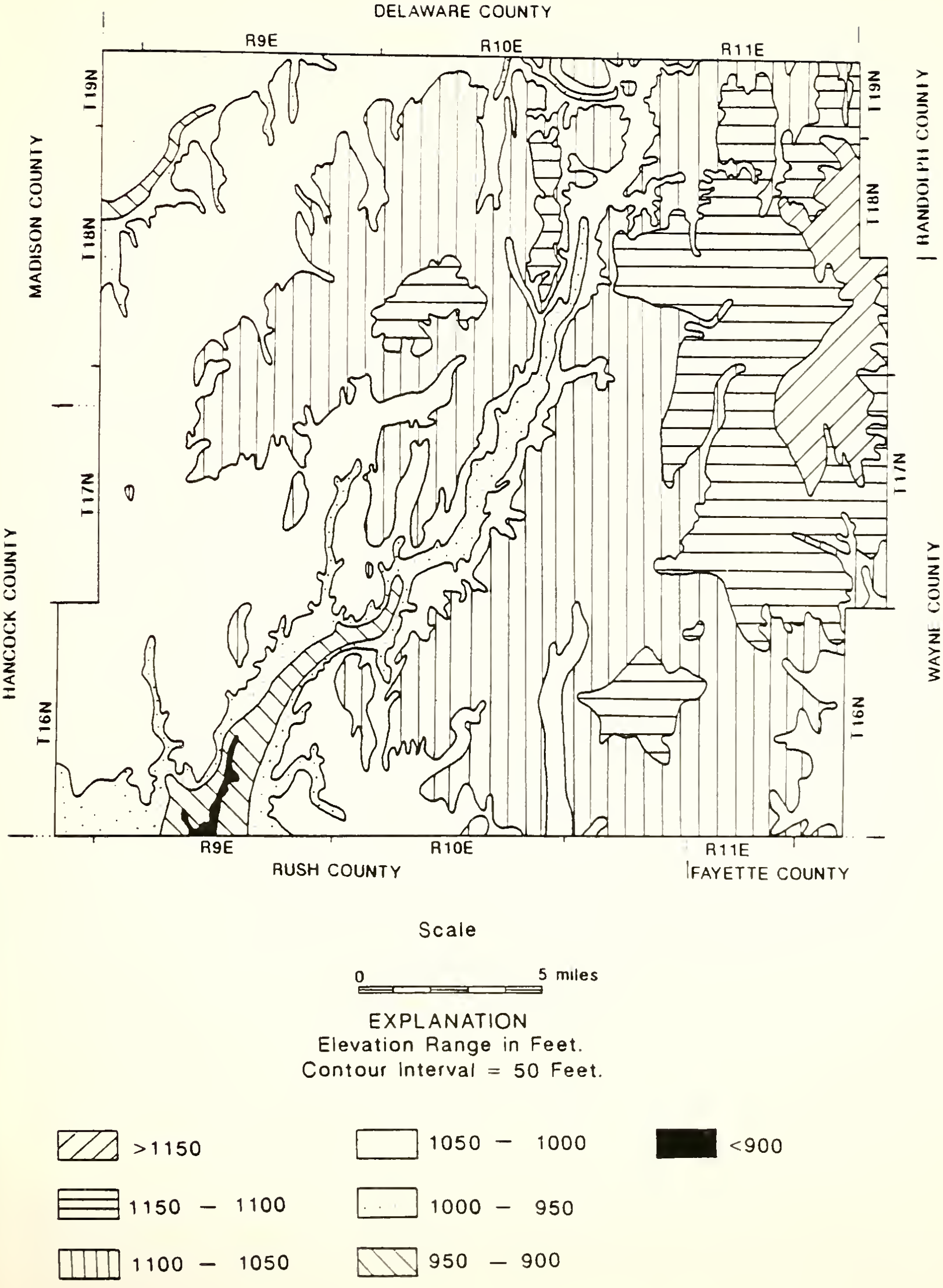


FIGURE 8 TOPOGRAPHIC MAP OF HENRY COUNTY (21,22)

dolomite and limestone, Devonian to Ordovician in age. The Quaternary sediments are mainly glacial deposits of the Pleistocene Epoch, but contain some Recent deposits (42-43).

STRUCTURAL GEOLOGY

Henry County lies on the western limb of the Cincinnati Arch, a broad crested anticline composed of rocks Ordovician to Pennsylvanian in age. Its axis trends north to northwest through Indiana, and dips of strata range from 35 feet or more per mile on the flanks, to low or indeterminate rates near the crest (36). The Cincinnati Arch is bordered by two large structural depressions, the Michigan Basin to the north and the Illinois Basin to the southwest (36).

BEDROCK GEOLOGY

Figure 9 is a map of the bedrock geology of Indiana. Henry County is underlain by rocks of Ordovician, Silurian, and Devonian ages as shown in Figure 10. Surface outcrops are unknown, but bedrock can be encountered at a shallow depth in deep stream channels. One now-abandoned stone quarry, located three miles north of Knightstown by the Big Blue River, was operational in the mid 1800's and produced dimension stone (39). A stratigraphic column of the bedrock in Henry County is shown in Figure 11.

The Ordovician rocks encountered on the bedrock surface include the Dillsboro and Whitewater formations and some undifferentiated shales and limestones. The Dillsboro Formation (Maquoketa Group, Ordovician System) consists of nearly equal parts of calcareous shale and argillaceous limestone at its type section in Dearborn County. To the north, however, shale becomes more dominant. The Dillsboro Formation is constantly about 400 feet in thickness. It is underlain by the Kope Formation, also of Ordovician Age, and is conformably overlain by the Whitewater Formation (40).

The Whitewater Formation (Maquoketa Group, Ordovician System) consists of a dolomite base unit (the Saluda Member) and interbedded shales and limestones. At its type section in

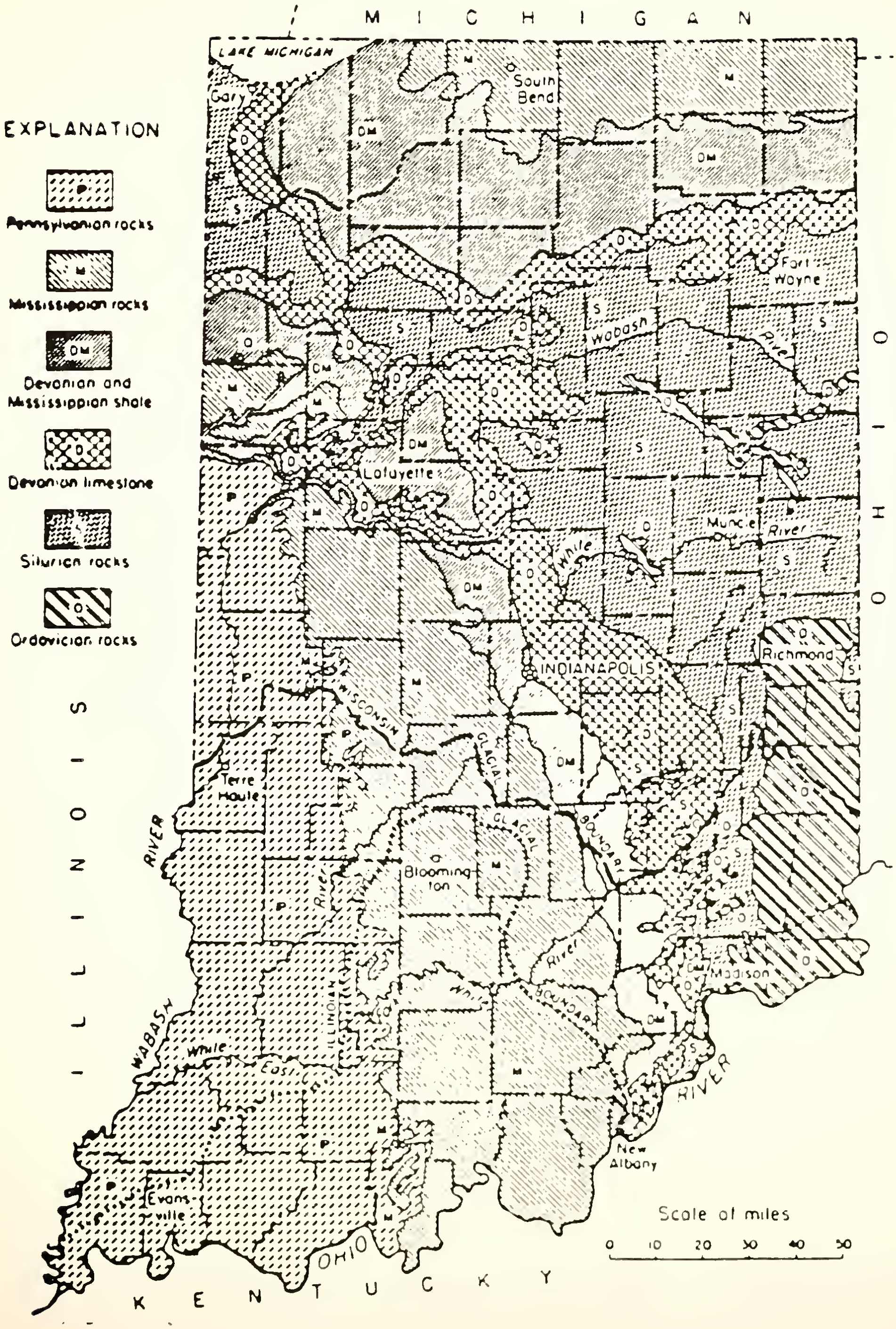


FIGURE 9 BEDROCK GEOLOGY OF INDIANA (37).

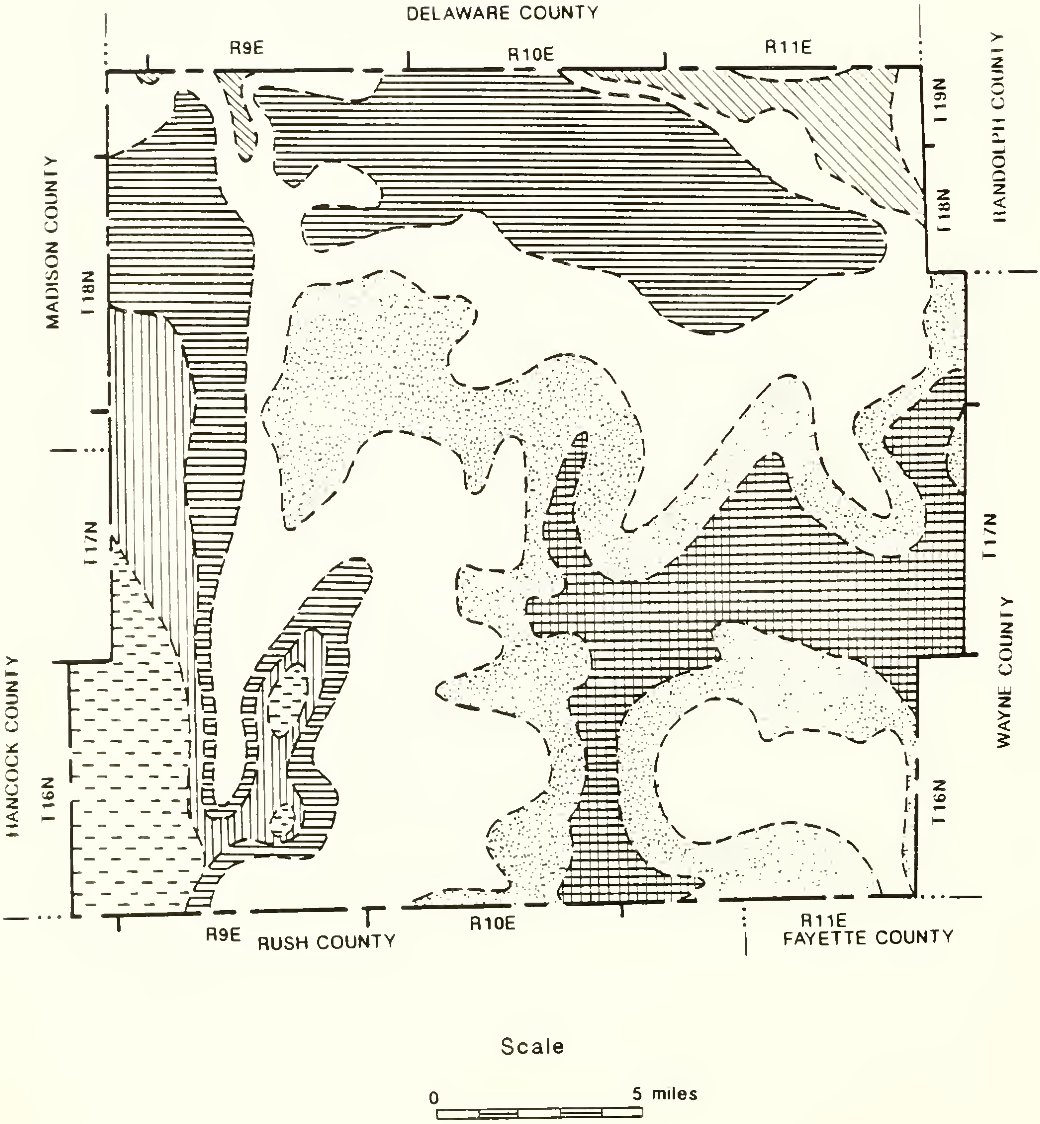


FIGURE 10 BEDROCK GEOLOGY OF HENRY COUNTY (38)

EXPLANATION

Devonian	Muscatatuck Group - Limestone and Dolomite
Silurian	Wabash Formation - Limestone, Dolomite, and Argillaceous Dolomite
	Pleasant Mills Formation - Dolomite, Limestone, and Argillaceous Dolomite
	Salamonie Dolomite, Cataract Formation, and Brassfield Limestone
Ordovician	Ordovician Rocks - Undifferentiated Shale and Limestone
	Whitewater Formation - Skeletal Limestone and Calcareous Shale Dolomitic Mudstone at base
	Dillsboro Formation - Skeletal Limetone and Calcareous Shale

FIGURE 10 (CONTINUED)

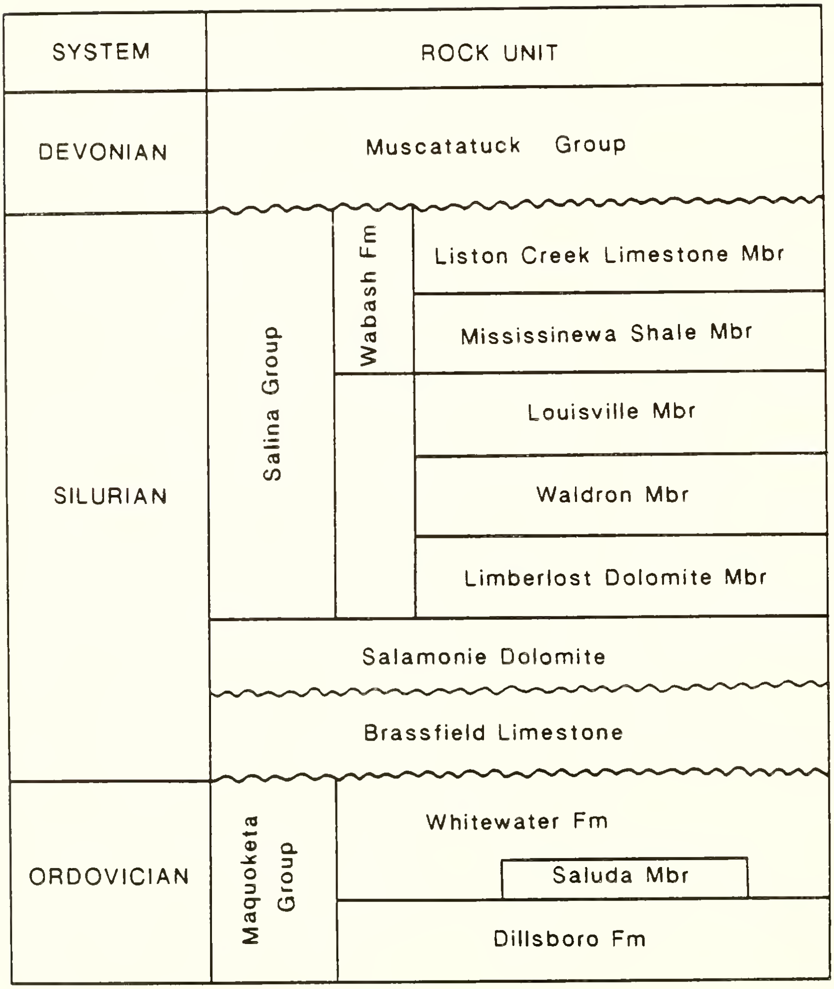


FIGURE 11 STRATIGRAPHIC COLUMN FOR ROCKS OF INTEREST IN HENRY COUNTY (40).

Wayne County, the Whitewater is about 100 feet thick. It is unconformable in its upper contact with the overlying Silurian rocks (40).

The Ordovician-Silurian boundary is marked by an unconformity which is commonly difficult to recognize (36). The Brassfield Limestone, poorly defined in the subsurface of northern Indiana, is the lowermost Silurian rock unit (36). In northern Indiana, the Brassfield averages 12 feet in thickness and consists generally of medium to coarse-grained fossiliferous limestone (36, 40).

The Salamonie Dolomite (Niagaran Series, Silurian System), unconformable in its lower contact with the Brassfield Limestone, is divided into three members in much of the northern third of Indiana. The lower member, characterized by abundant chert, is light-gray to tan, dense to fine-grained, argillaceous dolomite and dolomitic limestone. The middle member is a light-gray to white, granular, and porous dolomite. It has been referred to as reef-type dolomite because of its purity. The upper member is gray to brown limestone and dolomite. The combined thickness of the three members is over 200 feet in the southern Michigan Basin to the north (36). The Salamonie is conformable in its upper contact with the Salina Group.

The Salina Group (Niagaran and Cayugan Series, Silurian System) is composed of two formations, the Pleasant Mills Formation below and the Wabash Formation above. The Pleasant Mills Formation consists of pure carbonate rocks such as tan to brown, fine-grained to sugary dolomite. It is divided into three members, in ascending order, the Limberlost Dolomite Member, the Waldron Member, and the Louisville Member (40).

The Limberlost Dolomite Member, reclassified from its original formation status, dominantly consists of a light-brown, micritic to fine-grained dolomite. It ranges from zero to 70 feet in thickness, and is conformable in both its upper and lower contacts (40). The Waldron Member was also reclassified from its earlier designation as a formation. It is composed of shales which commonly interbed with silt and fossiliferous limestone layers. It ranges in thickness from one to thirty feet (40). Conformable in its lower contact with the Waldron Member, the Louisville

Member consists of light-colored to brown, fine-grained, argillaceous limestone and dolomitic limestone. It averages 40 to 70 feet in thickness (40).

The Wabash Formation, conformable with the underlying Louisville Member, contains two members, namely the Mississinewa Shale Member and the Liston Creek Limestone Member. The Mississinewa Shale Member consists of gray, dense to fine-grained, argillaceous dolomitic siltstone and silty dolomite. The upper member, the Liston Creek Limestone Member, consists of light-gray to tan, fine to medium-grained, cherty limestone and dolomitic limestone (40).

Overlying the Wabash Formation is the Muscatatuck Group of mostly Middle Devonian age. It is composed of several types of carbonate and evaporite rocks including dolomite, limestone, anhydrite, and gypsum (40).

Figure 12 is a map of bedrock topography. The highest elevations of the bedrock surface are 950-1000 feet and the lowest are 600-650 feet.

PLEISTOCENE GEOLOGY

Pleistocene and Recent sediment deposits account for all of the unconsolidated surficial material encountered in Henry County. Figure 13 is a map of the unconsolidated deposits of Henry County. The relationship between unconsolidated deposits is shown in Figure 14.

The till of the Trafalgar Formation covers the greatest area of the county. It is composed of mainly conglomeratic mudstones and associated thin lenses of gravel, sand, silt, and clay. The formation has two members, the Cartersburg and the Center Grove Tills, which are very difficult to distinguish in Henry County. The formation also is associated with three facies- the kame and esker facies, the end moraine facies, and the most abundant facies, the ground moraine facies. The upper surface of the Trafalgar is only slightly modified by erosion, but the base rests on an erosional unconformity (44).

The Atherton Formation contains gravel, sand, silt, and clay, derived primarily from outwash. It contains sediments from both the Kansan and Illinoian ages, but the majority of

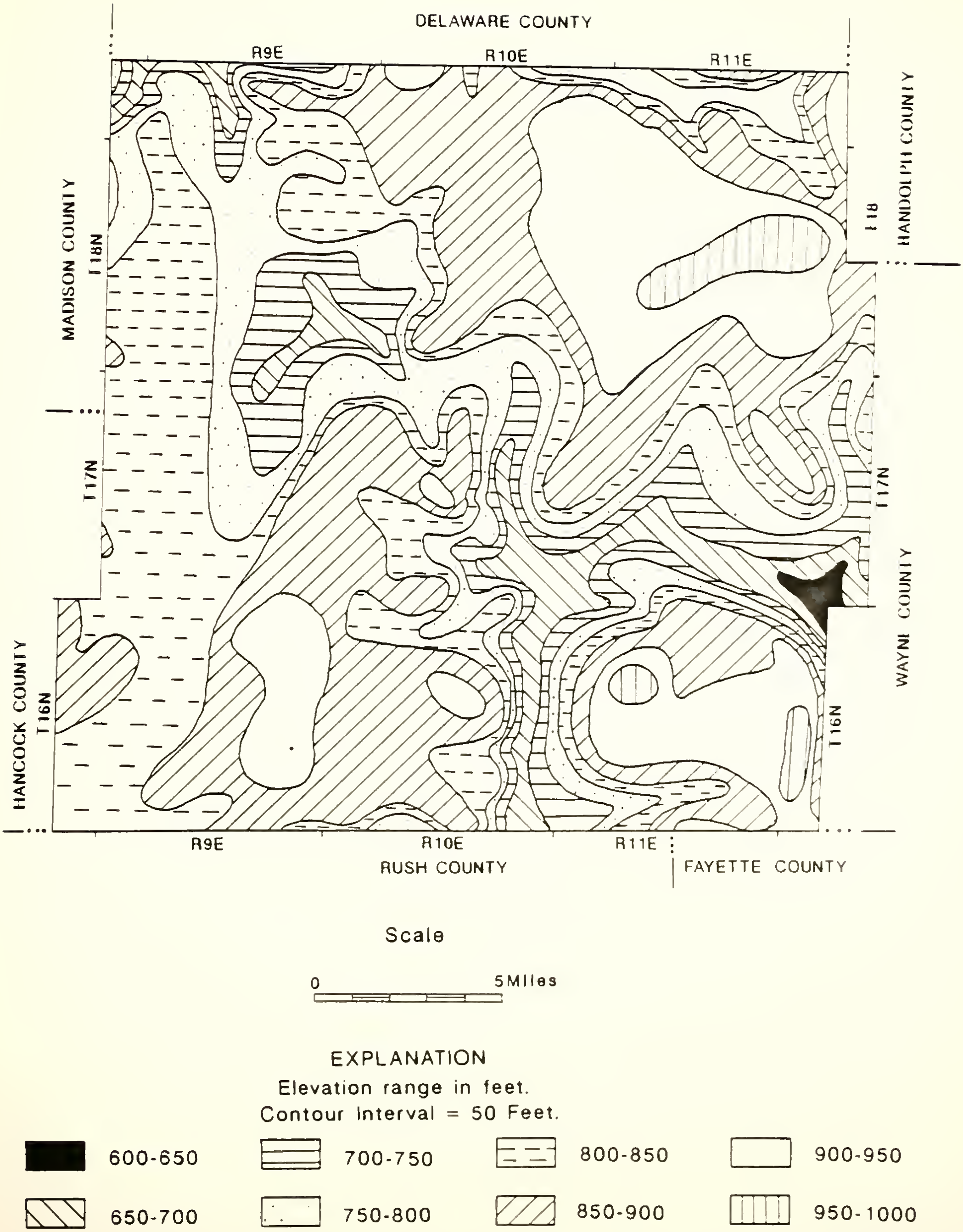


FIGURE 12 BEDROCK TOPOGRAPHY OF HENRY COUNTY (41)

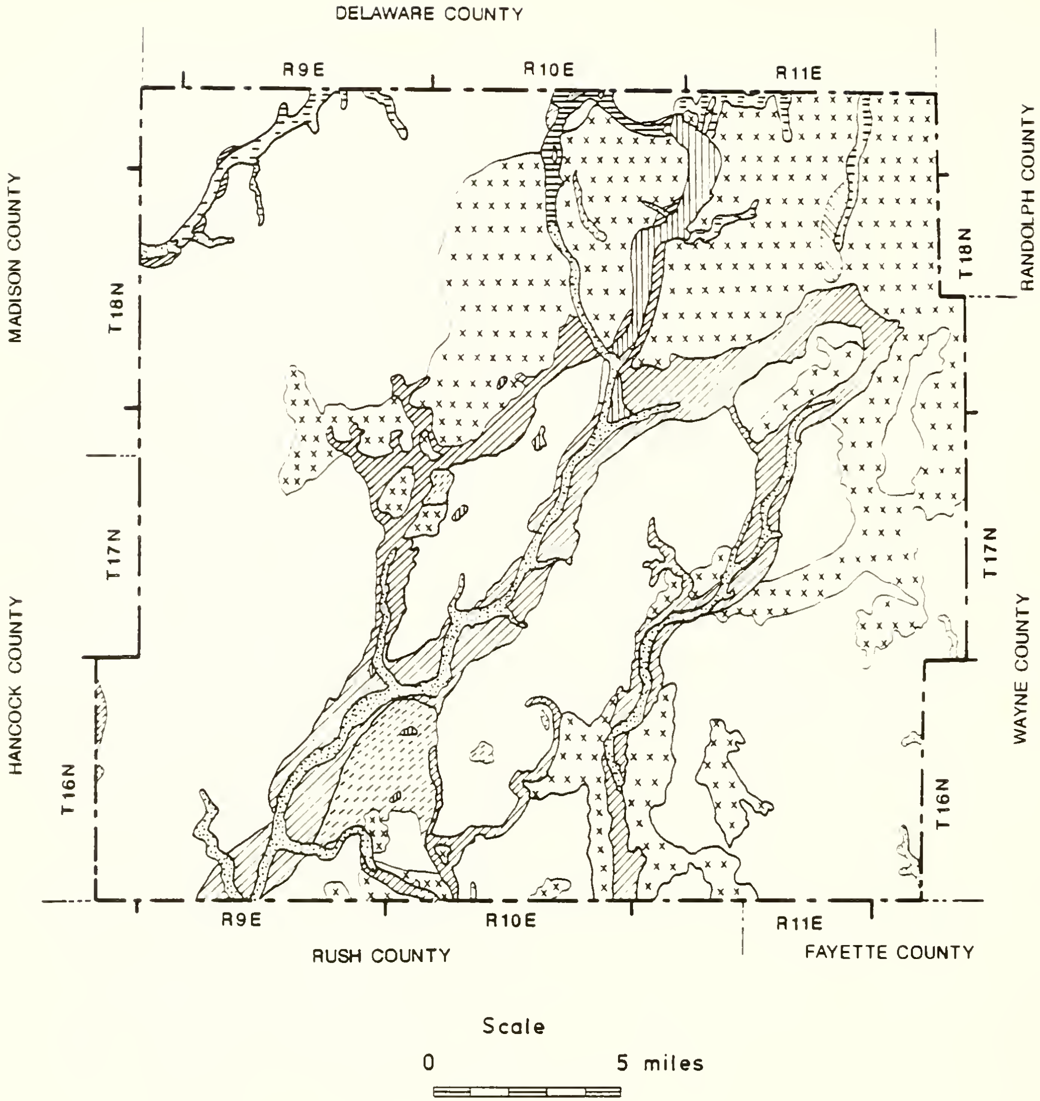
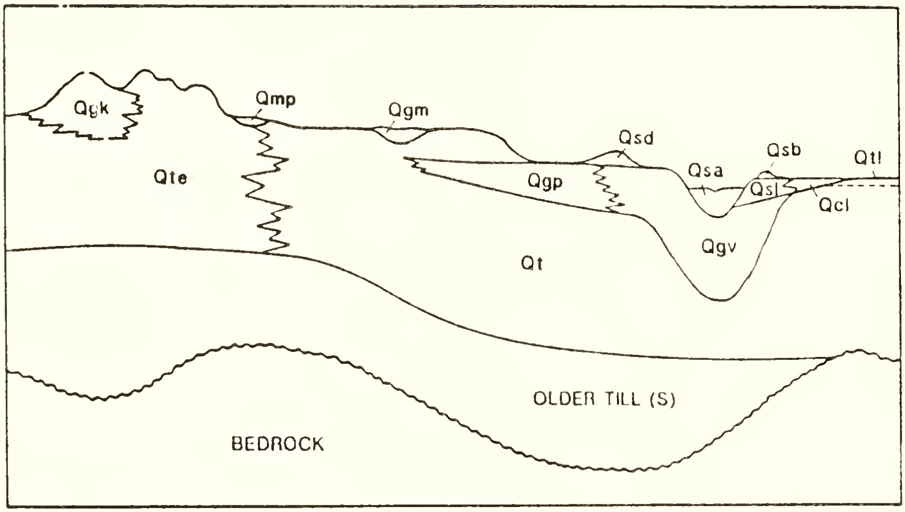


FIGURE 13 UNCONSOLIDATED DEPOSITS OF HENRY COUNTY (24,25).

EXPLANATION

Recent	Silt, Sand, and Gravel - Mostly Alluvium, Martinsville Formation
Wisconsinan and Recent	Muck, Peat, and Marl - Paludal and Lacustrine Deposits, Martinsville Formation
	Muck, Clay and Silt over Gravel Scattered deposits over outwash
Wisconsinan	Clay, Silt, and Sand. Lacustrine Facies of Atherton Formation
	Gravel, Sand, and Silt Valley-Train deposits; Outwash Facies of Atherton Formation
	Gravel, Sand, and Silt. Outwash plain Deposits of Atherton Formation
	Gravel, Sand and Silt. Kame and Esker Facies of Trafalgar Formation
	Till - Mainly Ground Moraine of Trafalgar Formation
	Till - Mainly End Moraine of Trafalgar Formartion

FIGURE 13 (CONTINUED)



EXPLANATION

Quaternary

Qsa	Silt, sand, and gravel
Qmp	Muck, peat, and marl
Qgm	Muck, clay, silt, and gravel
Qcl/Qsl	Clay, silt, and sand
Qsd/Qsb	Sand
Qgv/Qgp	Gravel, sand, and silt
Qgk	Gravel and sand
Qt/Qte	Till

FIGURE 14 SCHEMATIC SECTION SHOWING RELATIONSHIPS OF UNCONSOLIDATED DEPOSITS (42).

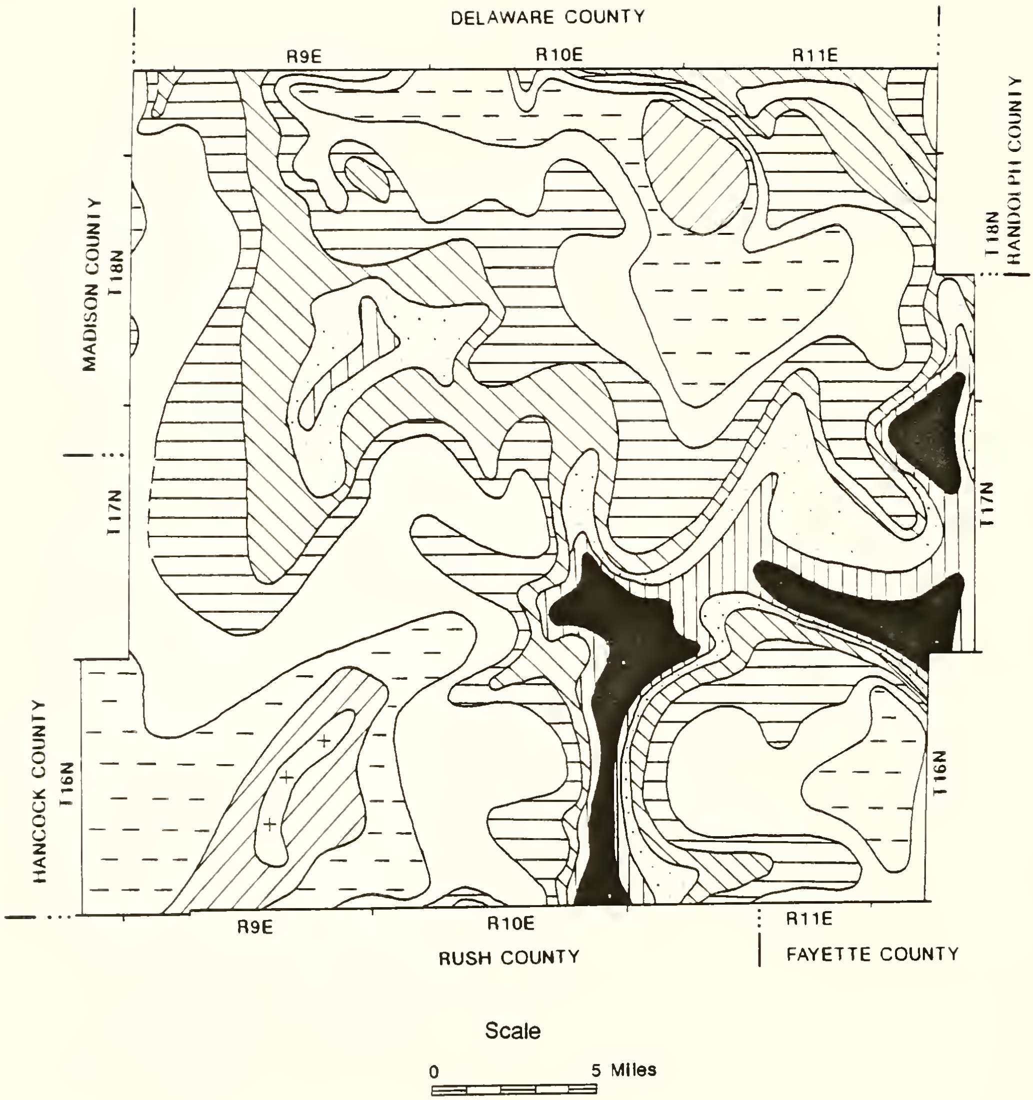
sediments are of Wisconsinan age. The Atherton is considered to have four facies, only two of which are present in Henry County.

The Outwash facies contains stratified sand and gravel which were deposited by glacial meltwaters as both sheets and valley fill material. It is disconformable with the overlying Martinsville. The Lacustrine facies consists of materials deposited in the blocked tributaries of valleys which once carried glacial meltwaters. By blocking the valleys, an environment of quiet water was created in which fine-grained materials settled. This facies commonly intergrades and intertongues with the outwash facies. Fossils are variable and abundant in these sediments (44).

The Martinsville Formation is the youngest of the unconsolidated materials. It contains silts, sands, and gravels which were deposited along flood plains of modern streams and peaty and calcareous muds which were deposited in small lakes and sloughs. Since the sediments are very young, there ordinarily is no zonal soil profile exhibited. The sediments of the Martinsville are of differing ages, but are all post-glacial. The Alluvial and the Paludal facies are the two known to the Martinsville (44).

The Alluvial facies consists mainly of clastic sediments such as silt and sand, but also contains lenses of gravel and organic mud. Since these sediments were deposited mainly in flood plains, they rarely contain fossils and commonly have a basal contact which is unconformable with the eroded surface below. The Paludal facies, on the other hand, consists of materials which were deposited in quiet water and thus are rich in organic matter such as peat, muck, and marl. The Paludal facies is considered fossiliferous (44).

The thickness of unconsolidated deposits in Henry County is shown in Figure 15. The thickest deposits, 400-450 feet, are nearly coincident with the locations of the deepest bedrock surface, as one might expect. The shallowest deposits, under 50 feet, occupy an area near Knightstown, along the Big Blue River; some boring logs record bedrock encounters at a fairly shallow depth here.



EXPLANATION

Elevation Range in Feet.
Contour Interval = 50 Feet.

+ +	0-50		150-200		300-350
	50-100		200-250		350-400
	100-150		250-300		400-450

FIGURE 15 THICKNESS OF UNCONSOLIDATED DEPOSITS (26)

LANDFORM-PARENT MATERIAL REGIONS

The soils in the county are derived primarily from unconsolidated materials. These materials are classified according to parent material and landform in the following section. Five parent material units-glacial drift, cumulose drift, glacial-fluvial drift, alluvial drift, and mined lands-are mapped in Henry County.

Each landform-parent material region is characterized by its overall extent, surface morphology and character, and general soil profile. Soils described in the typical profiles for the various parent materials are classified by the United States Department of Agriculture (USDA, e.g. silt loam), the American Association of State Highway and Transportation Officials (AASHTO, e.g. A-6), and the Unified Soil Classification System (USCS, e.g. ML-CL) rules. Classification results for the soil borings referred to in the following section can be found in Appendix A. Appendices C and D list information concerning physical and chemical properties of the soils and the engineering properties of the soils, respectively.

Engineering considerations for each parent material region are briefly discussed to give a general idea of the behavior of materials and possible problems encountered within each region. For more site-specific information, the reader is referred to the reports named in the reference list and to the information contained in Appendix A.

GLACIAL DRIFT

Wisconsinan aged glacial drift is the predominant type of parent material encountered in Henry County. Two main divisions of this parent material, ridge moraine and ground moraine, are recognized.

GROUND MORAINE

Ground moraine, which covers the largest portion of the county, is a heterogeneous mixture of gravel, sand, silt, and clay. Little or no sorting of the material occurred after deposition, thus the mixture of particles. Irregularly shaped and sized areas of highly organic topsoil are found in scattered locations around the county.

On aerial photographs, ground moraine appears as an intermixing of irregularly shaped and sized patches of light and dark tones. Light-colored areas, commonly on rises, reflect the generally more well-drained soils found there. The adjacent dark areas, however, indicate the presence of organic silts in poorly drained depressional areas and drainageways (46).

Topographically, ground moraine forms a gently rolling plain of low relief; local relief is generally less than 20 feet except in dissected areas and along valleys. Surface drainage is relatively young and undeveloped. However, gullies which form in fine-grained materials such as silty clay and clay are C-type, while gullies which form in coarse grained materials such as sand and gravel are V-type. Due to low relief, ground moraine is well suited to farming, where rectangular field and road systems are common (46).

There are three typical soil profiles for ground moraine, all of which formed from the underlying glacial till. The typical profile for the 'high' areas features a surface layer of 15-27 inches of silt loam (A-4, A-6; CL-ML, CL) underlain in the subsoil by silty clay loam (A-4, A-6; CL-ML, CL), clay loam (A-6, A-7; CL), or loam (A-4, A-6; CL, ML, CL-ML) from a depth of 15-60 inches. The underlying material is commonly a silt loam (A-4, A-6; CL-ML, CL).

The profile common to 'low' or depressional areas is very similar to the 'high' area profile, the main difference being the higher organic matter content in the depressions. The surface layer contains 15-27 inches of silt loam (A-4, A-6; CL, CL-ML) or 23-27 inches of silty clay loam (A-6, A-7; CL), both containing organic matter. The subsoil from a depth of 23-79 inches consists of silty clay loam (A-6, A-7; CL), clay loam (A-6, A-7; CL), and loam (A-4, A-6; CL, ML, CL-ML). The underlying material is silt loam (A-4, A-6; CL-ML, CL).

The profile for the areas of highly organic topsoil is also very similar to that of 'low' ground moraine. The surface layer may contain 6-18 inches of organic material or approximately 9 inches of muck (A-8; Pt) in silty clay loam (A-6, A-7; CL) or silty clay (A-6, A-7; CL).

Typical agricultural soil series for the 'high' areas included Crosby and Miami Series. Included in the 'low' profile were the Crosby, Miami, and Cyclone Series.

Soil borings located in ground moraine were numbers 1-26 and 27-28 (Appendix A).

RIDGE MORAINE

Ridge moraine covers the second largest area of Henry County. It is also a heterogeneous mixture of gravel, sand, silt, and clay, but commonly contains stratified seams of sand and gravel. It too forms rolling plains, but tends to have more relief than ground moraine; local relief is commonly greater than 20 feet.

On aerial photographs, ridge moraine also exhibits mottled or blotchy photo tones. Ground and ridge moraines are sometimes difficult to distinguish between, and boundaries are usually defined by a topographic break (46).

Drainage on ridge moraine is an intricate regional dendritic pattern, commonly supplemented by artificial drainage systems employing ditches or tiles. The most commonly encountered gully is the C-type. V-type gullies, however, can be found near areas with high relief or near major streams. A predominance of V-type gullies or a lack of gullies period is indicative of coarse-textured soils. More coarse-textured soils are also denoted by an increased percent of woodlots (46).

Formed in the underlying loamy glacial till, soil found in ridge moraine areas typically has two profiles. The surface layer of 'high' areas is 6-25 inches of silt loam (A-4, A-6; CL, CL-ML), or 25-45 inches of clay loam (A-6, A-7; CL), while the subsoil from a depth of 6-60 inches is clay (A-7, A-6; CL) or loam containing some seams of stratified sand and gravel (A-4; CL, ML, CL-ML). Underlying the subsoil is silt loam (A-4, A-6; CL-ML, CL, ML).

The profile typical of 'low' areas contains a 6 inch silt loam (A-4; ML) surface layer, subsoil layers from a depth of 6-60 inches of clay loam (A-4, A-7; CL), clay (A-6, A-7; CL), or loam (A-4, A-6; CL-ML). The underlying material is silt loam (A-4, A-6; CL-ML, CL, ML).

Agricultural soil series common to the 'high' areas include Losantville and Miamian, while the 'low' areas contain Celina and Miamian Series.

Soil borings located in ridge moraine are numbers 29-32, 33-40, and 41-45 (Appendix A).

ENGINEERING CONSIDERATIONS IN GLACIAL DRIFT

At first, the general level terrain of glacial drift areas appears to be suitable for almost any type of construction. It is soon realized, however, that glacial drift is devoid of necessary coarse-grained construction materials. The Miami, Miamian, and some Losantville soils are rated as good roadfill materials (1). The shrink/swell potential of glacial drift is low to moderate (1). And, the risk of corrosion of steel is moderate to high, while the risk for concrete corrosion is low to moderate (1).

Glacial drift areas with low slopes (1-6%), which includes most of the ground moraine areas, are plagued by slow or ponded runoff. The associated threat of frost action is moderate to high (1). Septic tanks and tile fields are severely limited due to slow percolation rates and, in some ridge moraine areas, slopes (1).

Roads constructed over ground moraine are prone to pavement pumping (46). Pavement pumping is the process in which water is ejected from cracks in rigid pavement in response to loads induced from passing vehicles (47). The ejected water carries away fine-grained fill material, leaving voids. As the voids grow, unsupported overlying pavement cracks and eventually collapses (47). The use of granular fill materials and bituminous pavement and provisions for adequate drainage will help reduce pavement pumping.

Foundations placed in glacial drift should be preceded by a detailed soil investigation. In general, however, ground moraine tends to be overconsolidated, hence, not likely to experience much settlement (48).

CUMULOSE DRIFT

One type of cumulose drift, the muck basin, is encountered in Henry County.

MUCK BASIN

Muck basins are pockets of highly organic materials commonly associated with high water tables, resulting in a mixture resembling sludge. Muck basins are formed in highly decomposed organic matter underlain by marl and loamy outwash materials. These basins of variable size and shape are frequently found in the north central section of the county, especially along the Big Blue River. In general, the larger the basin, the shallower the muck, but the potential for it to extend to several feet in depth always exists.

Muck basins are characterized by very dark gray to black photo tones, flat or concave topography, and a general lack of surface drainage. These basins are usually left in their natural state, but some larger basins may be drained and farmed (46).

The typical profile consists of a surface layer of about 15 inches of sapric material with up to five percent fibers (A-8; Pt), a subsoil of about 12 inches of marl underlain by about 30 inches of gravelly sandy loam to silty clay loam (A-4, A-6; CL, SC). The underlying material is silt loam (A-4, A-6; CL-ML, CL).

The agricultural soil series associated with muck deposits is the Martsico Series.

No soil borings are located in the muck pockets.

ENGINEERING CONSIDERATIONS IN CUMULOSE DRIFT

Cumulose drift is a highly organic material characterized by a naturally high water content, slow or ponded runoff, and low densities. The water table is seasonally at or near the ground surface. Some basins may be classified as wetlands and are thus protected under Federal law, an important aspect to investigate. When dry, however, this material is prone to subsidence, fire, and soil blowing if no vegetative cover exists.

Musk basins are unsuitable as locations for roads because of ponding, low and varying material strength, and low material density. Usually, when encountered in construction, if economically feasible, these materials are excavated and replaced with a suitable subgrade material. Replacement will help alleviate the problems of differential settlement, low strength, and allow for more efficient compaction. Ponding and the naturally high water content lead to freeze/thaw problems, but provisions for adequate drainage will help to eliminate this concern.

Muck basins are unsuitable as sites for septic tanks and tile fields due to slow percolation rates into the surrounding soils and the potential for ponding. Ponding is a prohibitive factor in the placement of sanitary landfills. Additionally, the presence of organic acids can be corrosive to concrete and steel placed in the soil.

GLACIAL-FLUVIAL DRIFT

There are four divisions recognized for discussion, namely outwash plains, kames and eskers, sluiceways, and terraces.

OUTWASH PLAINS

Outwash plains are level or gently undulating sheets of sand and gravel deposited by meltwater streams flowing from a glacier. Surface drainage is not well developed, and most of the drainage is internal. However, streams which cross outwash plains usually flow in abandoned meltwater channels known as sluiceways. The soils are generally stratified, coarse-textured materials with some fine-grained and organic matter found in depressed areas. Due to their low local relief, outwash plains are also well suited for rectangular field and road systems (46).

On aerial photographs, outwash plains exhibit a generally white to light-gray tone with specks of dark gray or black. The dark specks mark the silty or organic materials found in infiltration basins or channels. The uniform light tone represents well-drained coarse materials characteristic of outwash plains (46).

Soils encountered on outwash plains formed from the underlying outwash materials. The surface layer is typically a silt loam (A-4, A-6; ML, CL-ML, CL) of 9-10 inches in thickness, while the subsoil from a depth of 9-60 inches is silty clay loam (A-6; CL), clay loam (A-6, A-7; CL), or loam (A-4, A-6; CL-ML, CL). The underlying material is stratified sand and gravel (A-1, A-2; GM, SM, GP-GM, SP-SM, GP, SP) with occasional lenses of silt.

Agricultural soil series common to outwash areas include Eldean, Sleeth, Westland, Miami, and Treaty.

No soil borings were taken in outwash.

KAMES AND ESKERS

A kame is a conical shaped hill or cluster of hills composed of stratified sand and gravel. An esker is a sinuous ridge of nearly stratified sand and gravel, commonly paralleled on one or both sides by a trough. Distinct topographic expressions facilitate recognition of these landforms on aerial photographs.

Drainage on kames and eskers is poorly defined and poorly developed. However, the coarse nature of materials allows a few streams to form v-typed gullies and assume a radial or downslope-parallel form. Because of the extreme slopes, runoff tends to be rapid. Sheet erosion is responsible for removing fine grained materials from higher positions to lower positions where they are redeposited, thus allowing for farming on the lower, more gentle slopes (46).

The surface layer of a typical profile is silt loam (A-4, A-6; ML, CL-ML, CL) 6-15 inches in thickness, while the subsoil from a depth of 6-60 inches consists of loam (A-6; CL), clay loam (A-7, A-6; CL, ML), silty clay loam (A-6; CL), clay (A-7, A-6; CL, ML), or gravelly sandy loam (A-2; SC). The underlying material is stratified sand and gravel (A-1, A-2; GM, SM, GP-GM, SP-SM).

Agricultural soil series common to kames and eskers include Eldean, Losantville, and Miami.

No soil borings were made in these locations.

SLUICEWAYS

Glacial sluiceways, which once conveyed the great volumes of glacial flood waters, are valleys which now contain underfit streams or drainage ditches. On aerial photographs, sluiceways display much the same photo tone as that of outwash; they can be thought of as channelized outwash.

A typical profile has a surface layer of silt loam (A-4, A-6; ML, CL-ML, CL), or loam (A-4, A-6; ML, CLM CL-ML) 8-10 inches in thickness, both of which have pockets of highly organic to mucky soils. The subsoil from 8-60 inches in depth contains clay loam (A-6; CL), sandy clay loam (A-6; SC), loam (A-6; CL), gravelly loam (A-4; CL), gravelly clay loam (A-6, A-7; CL), or gravelly sandy loam (A-2; SC). The underlying material is loam and sand and gravelly coarse sand (A-2, A-1; SP, GP SP-SM, GP-GM), stratified in some locations.

Agricultural soil series common to sluiceways include Millgrove, Sleeth, Treaty, and Westland.

Soil borings 46-48 and 49-53 are located in sluiceways.

TERRACES

Stream terraces are nearly level to gently undulating plains confined within a valley and located above the level of the stream. Terraces are rarely flooded except for the lowest lying ones. They represent former levels of stream beds, valley floors, or abandoned flood plains. Drainage on terraces consists mainly of subsidence basins or swallow holes and a few V-type gullies, all indicative of the presence of coarse materials. CV-type gullies can be found in areas where a thick mantle of cohesive soils overlay non-cohesive soils (46).

On aerial photographs, these well-drained materials appear as light-colored areas with occasional dark scars or channels, composed of moist clays or silty clays, indicating a reworked surface. In general, the soils are stratified sands and gravels with lenses of silt and clay. As the lower terraces are more likely to be flooded, they generally contain more silt and clay (46).

The surface layer of a typical soil profile on a terrace consists of 6-10 inches of loam (A-4, A-6; ML, CL, ML-CL) or silt loam (A-4, A-6; ML, ML-CL, CL) with some organic material. The subsoil from 6-60 inches in depth is a clay loam (A-6; CL) or gravelly loam (A-4; CL), and the underlying materials are stratified sand and gravel (A-1, A-2; SC, SM-SC).

Agricultural soil series included Eldean, Sleeth, and Millgrove.

No soil borings were taken in terrace areas.

ENGINEERING CONSIDERATIONS IN GLACIAL-FLUVIAL DRIFT

Outwash plains are good potential sources for coarse materials such as sand and gravel. Rapid infiltration in the underlying material must be considered when contemplating septic tank or sanitary landfill sites since potential for groundwater contamination exists. The high permeability of the sand and gravel permits good water production in some areas, as discussed previously.

Kames and eskers are a potentially good source for necessary construction materials. As previously mentioned, fine-grained materials tend to be concentrated on the bottom slopes, thus contributing to the variability of excavation depth needed to reach the desired materials.

The steep slopes of kames and eskers limit their use except for activities such as farming or gravel pit operations. Regardless of the activity, however, care must be taken to reduce erosion potential. Practices to reduce erosion include constant maintenance of a vegetative cover, conformance to contours, and cutting and filling of areas to reduce slope failures. Likelihood of slope failure can be reduced by not removing the toe of a slope, not overloading the head of a slope, and not oversteepening the slope itself. The intersection of a saturated layer with a slope will increase the potential for slope failure. For this reason, and because of highly permeable substrata, septic tanks should not be placed here.

Sluiceways are good sources of coarse-grained construction materials. The water table is seasonally high, generally within three feet of the surface from November to May (1). Flooding is also a risk, and excavation operations should consider these factors. Excavations made and slopes cut into sluiceways should be properly drained to prevent collapse.

The risk of frost action and steel corrosion is high for soils developed in sluiceways (1). The concrete corrosion risk, however, is low (1).

The frost action potential for soils developed on terraces is moderate to high (1). The risk of corrosion for concrete is low to moderate, while for steel, it is high (1).

Terraces generally do not flood except for the low-lying ones. There also the water table is seasonally high (1).

ALLUVIAL DRIFT

Alluvial drift is encountered in the form of flood plains in Henry County. Many more flood plains exist in the county than were able to be mapped at this scale.

FLOOD PLAINS

A flood plain is a plain of low relief, confined within the walls or slopes of a valley or within levees, which is covered with water when a nearby stream is at or above flood stage. On aerial photographs, flood plains appear as dark areas, indicative of poor drainage, fine grained materials, or wet areas. Drainage forms within flood plains are variable.

Recalling the variability in floods with time and the associated variability in both rates and amounts of material deposition, extreme variation in the soil profiles with both depth and area must be considered.

In general, the surface soils consist of silt loam (A-4, A-6; ML, CL), loam with occasional silt pockets (A-4, A-6; ML, CL), or silty clay loam (A-6, A-7; CL), all with organic materials possible. Generally, coarse-textured material is not abundant, but at depth, some large pockets can be found. Additionally, pockets of organic material and silt lenses are also present at depth.

Agricultural soil series include Genessee, Landes, Shoals, Sleeth, Washtenaw, and Westland.

Soil borings located in flood plains are numbers 54-57, 58-62, 63-64, 65-68, 69-71, 72-74, 75-77, 78-80, 81-88 (Appendix A).

ENGINEERING CONSIDERATIONS IN FLOOD PLAINS

Of greatest concern in flood plains is the constant threat of flooding, and for that reason, locating structures within a flood plain is ill-advised. However, some protection from flooding can be achieved through use of levees, dikes, or other flow diversion techniques.

If structures must be constructed within a flood plain, vast variability in soils encountered should be anticipated, and therefore, detailed site investigations should be performed. During the site investigation, it is likely that concerns for differential settlement, low material strength, organic materials, and saturated conditions will be recognized. Steel corrosion risk is low in the Genessee and Landes soils, but high in the other soils (1). Concrete corrosion risk is low in all soils (1).

Roads built through flood plains should be constructed on raised, well compacted, suitable materials. Provisions for adequate drainage should be made to reduce the moderate to high frost action potential and flood damage.

As the material type varies, so does the permeability. In general, though, permeability in the surface layers tend to be slow to moderate, while in the sublayers rapid. This adds to the list of reasons not to construct septic systems or sanitary landfills in floodplains.

MINED LANDS

A number of gravel pits, some abandoned, some active, exist in Henry County.

GRAVEL PITS

Gravel pits are areas where soil has been removed to access the sand and gravel below. Gravel pits vary in size and depth, but are generally rectangular and range from three to 80 acres in size (1). Some pits contain water and may be classified as wetlands. These pits are not suited for urban or farm activities and are typically used for recreation areas or wildlife habitats (1).

ENGINEERING CONSIDERATIONS IN MINED LANDS

Occasionally, abandoned gravel pits are reopened to extract more materials but only when economically feasible. They have been used as landfills before, but proper precautions must be taken to safely use them as such. It is important that steps be taken to prevent leachate migration not only through the landfill bottom, but also laterally through the sides. A groundwater monitoring system is typically recommended to help safeguard against contamination.

SUMMARY

Engineering considerations for the landform-parent material regions of Henry County are given in Table 7. The table lists the probability of developing major problems in the various regions and should be used only as a general guide in planning. The engineering problems are discussed in more detail in the earlier sections of this report.

Table 7 Summary of Engineering Considerations for Landform-Parent Material Regions

Explanation

Likelihood of a Major Problem Developing
L — Low
M — Medium
H — High

Availability Rating
1 — Low
2 — Medium
3 — High

Landform	General Soil Texture	Cut Design: Soil Backslope Stability	Cut Design: Groundwater Control	Cut Design: Erosion	Cut Design: Surface Drainage	Cut Design: Natural Slope Stability	Embankment Fill (Compacted Properties): Erosion	Embankment Fill (Compacted Properties): Relative Permeability	Embankment Fill (Compacted Properties): Shear Strength	Embankment Fill (Compacted Properties): Compressibility When Saturated	Embankment Fill (Compacted Properties): Workability	Embankment Foundation: Settlement	Embankment Foundation: Shear Strength	Embankment Foundation: Organic Deposits	Highway Subgrade: Frost Action	Highway Subgrade: Pumping	Highway Subgrade: Shrink/Swell	Foundation Design: Bearing Capacity	Foundation Design: Settlement	Miscellaneous: Septic Systems	Miscellaneous: Groundwater Resource	Miscellaneous: Aggregate Supply	Miscellaneous: Steel Corrosivity	Miscellaneous: Concrete Corrosivity
Ground Moraine	Silt, Clay, and Sand	L	L	L/M	M/H	L	M	1	L/M	M	L	L	L	L/M	M/H	M/H	L/M	L	L	H	1	1	M/H	L/M
Ridge Moraine	Silt, Sand and Gravel	L	L	L/M	M/H	L/M	M	1	L/M	M	L	L	L	L	M/N	M/H	L/M	L	L	H	1	1	M/H	L/M
Muck Basin	Muck, Peat, and Marl	H	L	H	M/H	H	H	1-2	H	H	H	H	H	H	H	M	H	H	H	H	1	1	H	L
Outwash Plain	Sand, Silt, and Gravel	L	M/H	M	L	L	M	2-3	L	L	L	L	L	L	L/M	L	L	L	L	L	2-3	3	H	L/M
Kames & Eskers	Sand, Silt, and Gravel	L	L/M	M	L	L	M	2	L/M	L/M	L	L	L	L	L/M	L/M	L/M	L	L	M/H	1-2	3	M/H	L/M
Sluiceways	Sand, Silt, and Gravel	L/M	M/H	M	L	L	M	2-3	L	L	L	L	L	L/M	L/M	L	L	L	L	L/M	2-3	2	H	H
Terraces	Sand, Silt, and Gravel	L	M/H	M	L	L	M	2-3	L	L	L	L	L	L	L/M	L	L	L	L	L	2-3	3	H	L/M
Flood Plains	Sand, Silt, Gravel, and Clay	M	M	M/H	L/M	L/M	M	1-3	M	M	L/M	L/M	L/M	M	M/H	L/M	L/M	M/H	L/M	M/H	2	2	L/M	L

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Appendix A

Classification Test Results for Selected Engineering
Projects in Henry County (49-64).

Appendix A-1 Borehole Data for SR 3 in Henry County (56).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
1	1(2)	239 + 00	10 L	1075.8	0.3 - 2.0	Silty Loam	A-6(10)	-	-	-	25	57	18	32	18	14
2	2(1)	245 + 95	48 R	1073.1	0.0 - 2.0	Silty Loam w/trace Organics	A-7-6(16)	-	-	-	19	61	20	49	24	25
2	2(BAG)	"	"	"	2.0 - 6.0	Silty Clay Loam w/trace Organics	A-6(12)	-	-	-	24	53	23	40	19	21
3	3(1)	255 + 00	42 L	1073.1	4.0 - 6.0	Sandy Loam w/trace Organics	A-6(4)	-	-	-	53	27	20	31	16	15
4	4(1)	264 + 50	6 R	1081.0	2.0 - 4.0	Clay	A-6(5)	-	-	-	46	24	30	29	15	14
5	5(1)	270 + 00	42 L	1078.3	2.0 - 4.0	Silty Loam	A-4(7)	-	-	-	30	68	2	21	15	6
6	8(1)	293 + 00	42 L	1073.4	4.0 - 6.0	Clay	A-6(11)	-	-	-	31	38	31	37	18	19
7	9(BAG)	303 + 00	15 R	1075.8	0.2 - 2.0	Silty Clay	A-7-6(16)	-	-	-	9	55	36	46	19	27
7	9(BAG)	"	"	"	2.0 - 4.0	Silty Loam	A-4(8)	-	-	-	13	83	4	21	16	5
7	9(BAG)	"	"	"	4.0 - 6.0	Clay Loam	A-6(5)	-	-	-	46	32	22	23	12	11
8	12(4)	326 + 90	27 L	1055.4	10.0 - 11.5	Clay Loam	A-4(6)	13	80	-	36	39	25	19	11	8
9	14(1)	336 + 10	50 L	1071.8	1.0 - 2.5	Clay w/little Organics	A-7-6(12)	-	-	-	36	32	32	42	20	22
10	20(1)	366 + 10	30 R	1082.8	2.0 - 4.0	Sandy Clay Loam	A-7-6(5)	-	-	-	64	7	29	50	23	27
11	22(2)	376 + 35	40 L	1092.0	8.0 - 10.0	Clay	A-6(5)	-	-	-	45	24	31	23	12	11
12	24A(1B)	393 + 55	30 L	1079.8	0.2 - 8.0	Clay	A-7-6(11)	-	-	-	46	18	36	46	20	26
13	25(1)	396 + 00	27 L	1072.5	0.0 - 2.0	Sandy Loam w/trace Organics	A-6(5)	-	-	-	52	28	20	37	21	16

Appendix A-1 Borehole Data for SR 3 in Henry County (56) Continued.

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
14	26(1)	403 + 05	50 L	1058.9	0.0 - 2.0	Sandy Loam	A-2-4(0)	-	-	-	68	26	6	23	21	2
14	26(2)	"	"	"	2.0 - 4.0	Sandy Loam	A-6(2)	-	-	-	57	29	14	27	16	11
15	28(3)	416 + 80	40 L	1036.5	5.0 - 6.5	Sand	A-1-b(0)	20	80	-	92	5	3	NP	NP	NP
16	28A(BAG)	420 + 50	40 R	1059.5	4.0 - 16.0	Clay Loam	A-6(4)	-	-	-	51	26	23	23	12	11
16	28A(1)	"	"	"	16.0 - 18.0	Clay Loam	A-6(5)	-	-	-	46	25	29	22	11	11
17	30(BAG)	429 + 00	40 R	1058.7	0.3 - 4.0	Clay Loam	A-6(5)	-	-	-	57	15	28	40	18	22
17	30(3)	"	"	"	6.0 - 8.0	Clay Loam	A-6(1)	-	-	-	67	12	21	25	11	14
18	32(2)	440 + 25	57 L	1007.8	3.0 - 3.5	Sandy Loam w/trace Organics	A-1-b(0)	-	-	-	79	18	3	22	18	4
18	32(4)	"	"	"	8.0 - 10.0	Clay Loam	A-4(4)	-	-	-	48	30	22	22	14	8
19	33(2)	449 + 00	28 R	1022.5	2.0 - 3.5	Sandy Loam	A-6(4)	-	-	-	50	37	13	32	19	13
20	34(3)	459 + 55	40 L	1031.8	5.0 - 6.0	Sandy Loam	A-2-7(2)	-	-	-	70	16	14	42	19	23
21	36(1B)	472 + 00	50 L	1027.6	2.5 - 5.0	Sand	A-1-b(0)	-	-	-	96	1	3	NP	NP	NP
22	37A(6)	476 + 50	75 L	1002.2	15.0 - 16.5	Clay Loam	A-4(4)	16	70	-	44	30	26	21	12	9
23	40(2)	494 + 00	60 R	995.8	4.0 - 6.0	Clay Loam	A-6(8)	-	-	-	32	40	28	33	20	13
24	41(1)	501 + 70	45 L	986.0	4.0 - 6.0	Sand	A-2-4(0)	-	-	-	80	12	8	13	12	1
25	42B(3)	518 + 85	42 L	972.3	7.3 - 8.0	Clay Loam w/little Organics	A-7-6(12)	-	-	-	39	38	23	52	29	23
26	43A(2)	520 + 10	45 L	973.1	6.0 - 7.0	Sandy Clay w/little Organics	A-7-5(4)	-	-	-	64	1	35	63	36	27
26	43A(3)	"	"	973.1	7.0 - 8.0	Sandy Loam w/some Organics	A-4(3)	-	-	-	55	38	7	15	NP	NP
26	43A(4)	"	"	973.1	9.0 - 10.0	Sand	A-1-b(0)	-	-	-	95	0	5	NP	NP	NP

Appendix A-2 Borehole Data for CR 200N at N&W Railroad in Henry County (59).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
27	RB1(1)	18 + 32	CL	1037.4	1.0 - 2.5	Sandy Loam & Gravel	A-1-b(0)	13	80	47.4	29.1	15.7	7.8	NP	NP	NP
27	RB1(3)	"	"	"	6.0 - 7.5	Sandy Gravel	A-1-a(0)	32	100	52.6	41.8	3.6	2.0	NP	NP	NP
28	RB2(BAG)	19 + 40	21 L	1056.4	1.0 - 3.5	Clay	A-6(13)	-	-	2.6	25.7	35.7	36.0	39	19	20
28	RB2(3)	"	"	"	6.0 - 7.5	Clay Loam	A-4(1)	50	100	6.9	24.1	44.9	24.1	24	19	5

Appendix A-3 Borehole Data for Messick Road from US 36 to CR 600N in Henry County (53).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
29	RB1(1)	13 + 00	15.5 R	1112.9	1.0 - 2.5	Clay Loam	A-6(7)	10	80	15.5	24.2	31.5	28.8	35	19	16
30	RB4(2)	40 + 00	23.0 R	1099.2	3.5 - 5.0	Clay Loam	A-4(1)	22	100	11.5	28.4	38.2	21.9	21	15	6
31	RB5(2)	50 + 00	12.5 R	1098.4	3.5 - 5.0	Silty Clay Loam	A-6(12)	7	100	0.0	8.2	63.6	28.2	33	19	14
32	RB7(BAG)	47 + 50	23.0 R	1111.1	1.0 - 3.0	Silty Clay	A-7-6(22)	-	-	1.4	8.3	53.6	36.7	43	19	24

Appendix A-4 Borehole Data for Greenfield Rest Areas on I-70 in Henry County (61).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
33	WB1(3)	61 + 40	170 L	996.2	6.0 - 7.5	Sandy Loam	A-2-4(0)	5	50	1.6	74.7	21.6	2.1	NP	NP	NP
34	WB1(5)	"	"	"	13.5 - 15.0	Sandy Loam	A-4(0)	13	100	15.1	38.5	37.7	8.7	NP	NP	NP
35	WB2(1)	61 + 82	108 L	1001.7	1.0 - 2.5	Loam	A-4(4)	8	65	5.4	28.6	47.0	19.0	26.2	15.9	10.3
36	WB3(2)	62 + 25	170 L	996.9	3.5 - 5.0	Clay Loam	A-7-6(25)	13	80	0.2	10.5	57.1	32.2	47.1	20.0	27.1
37	WB3(4)	"	"	"	8.5 - 10.0	Loam	A-4(1)	27	100	7.1	28.7	47.1	17.1	20.1	13.5	6.6
38	WB5(2)	35 + 00	15 R	1000.5	3.5 - 5.0	Silty Loam	A-4(1)	9	100	4.6	14.6	68.2	12.6	22.1	17.8	4.3
39	WB6(1)	59 + 50	20 R	1000.2	1.0 - 2.5	Loam	A-4(1)	33	75	9.4	30.2	45.0	15.4	20.2	13.2	7.0
40	WB10(6b)	25 + 10	50 L	992.9	19.5 - 20.0	Gravelly Sand	A-2-4(0)	57	80	25.5	54.9	15.7	3.9	NP	NP	NP

Appendix A-5 Borehole Data for SR 38 at Middletown Road in Henry County (63).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
41	82PT(1)	48 + 82	20 L	1063.8	9.0 - 11.0	Loam	A-6(3)	-	100	9.8	37.1	35.2	17.9	27.6	15.6	12
42	83(8)	48 + 85	73 R	1048.7	18.5 - 20.0	Sand	A-1-b(0)	17	100	5.8	90.5	<--3.7-->		NP	NP	NP
43	B4(3)	18 + 70	20 R	1064.3	6.0 - 7.5	Silty Clay Loam	A-6(7)	14	90	0.9	23.3	54.7	21.1	29.7	18.1	11.6
44	B5(3)	51 + 14	20 L	1063.9	6.0 - 7.5	Sandy	A-2-4(0)	12	90	6.5	75.7	<-17.8-->		NP	NP	NP
45	B7(BAG)	58 + 85	20 L	1052.0	3.0 - 6.0	Loam	A-6(6)	-	-	6.5	27.9	45.8	19.8	30.6	17.2	13.4

Appendix A-6 Borehole Data for CR 100S over Duck Creek in Henry County (51).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
46	RB4(1)	50 + 33	25 L	1012.3	1.0 - 2.5	Sandy Loam	A-4(2)	34	70	13	38	36	13	31	21	10
47	TB1(BAG)	18 + 02	4 L	1013.3	3.5 - 5.0	Clay Loam	A-6(7)	-	-	9	31	36	24	33	16	17
47	TB1(6)	"	"	"	18.5 - 20.0	Sand & Gravel	A-1-a(0)	23	65	50	45	<--5-->		NP	NP	NP
48	TB2(2)	18 + 35	12 R	1007.6	6.5 - 8.0	Loam	A-4(0)	14	100	9	35	40	16	18	12	6
48	TB2(4)	"	"	"	11.5 - 13.0	Sand	A-3(0)	31	100	7	86	<--7-->		NP	NP	NP

Appendix A-7 Borehole Data for CR 600S over Big Blue River in Henry County (60).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
49	TB1(7)	142 + 75	30 R	1058.2	23.5 - 25.0	Silty Clay Loam	A-4(7)	7	100	0	11	65	24	25	15	10
50	TB2(1)	143 + 23	11 R	1064.6	1.0 - 2.5	Silty Loam	A-6(9)	4	60	4	30	51	15	34	17	17
50	TB2(15)	"	"	"	63.5 - 65.0	Gravelly Sand	A-1-b(0)	12	100	43	56.6	<-0.4-->		NP	NP	NP
51	TB3(12)	143 + 51	11 L	1064.7	48.5 - 50.0	Sandy Loam w/some gravel	A-4(0)	30	-	23	34	33	10	19	12	7
52	TB4(3)	144 + 08	30 R	1057.8	6.0 - 7.5	Silty Clay Loam	A-6(13)	7	100	0	4	72	24	31	17	14
51	TB4(7)	"	"	"	23.5 - 25.0	Silty Loam	A-4-(0)	6	80	0	19	69	12	17	14	3

Appendix A-8 Borehole Data for CR 800W over Fall Creek in Henry County (50).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
54	RB1(Bag)	10 + 00	20R	928.8	3.5 - 5.0	Clay	A-7-6(22)	-	-	0	21	45	34	46	18	28
55	TB1(2)	13 + 45	15L	931.1	3.5 - 5.0	Loam	A-4(4)	12	80	0	32	50	18	30	21	9
55	TB1(5)	"	"	"	13.5 - 15.0	Sand & Gravel	A-1-b(0)	35	100	49	46	<--5-->		NP	NP	NP
56	TB2(2)	14 + 14	15 R	926.8	4.5 - 5.0	Sandy Loam	A-4(0)	6	90	0	53	31	16	23	18	5
56	TB2(8)	"	"	"	28.5 - 30.0	Clay Loam	A-6(8)	42	100	3	30	40	27	31	15	16
57	TB4(2)	15 + 11	15 L	932.9	3.5 - 5.0	Sandy Loam	A-4(1)	9	50	9	40	37	14	25	17	8
57	TB4(8)	"	"	"	28.5 - 30.0	Clay Loam	A-4(3)	49	100	3	27	46	24	23	14	9

Appendix A-9 Borehole Data for CR 850N over Fall Creek in Henry County (52).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
58	RB1(BAG)	13 + 50	34 R	933.0	1.0 - 2.5	Clay	A-7-6(15)	-	-	0	18	49	33	45	29	16
59	RB2(3)	50 + 00	70 L	935.0	6.0 - 7.5	Gravelly Sand	A-1-b(0)	23	50	38	56	<--6-->		NP	NP	NP
60	TB1(5)	10 + 25	15 R	936.5	13.5 - 15.0	Sandy Loam	A-2-4(0)	45	50	13	59	20	8	20	18	2
60	TB1(8)	"	"	"	29.5 - 30.0	Silty Clay	A-4(9)	16	100	0	1	68	31	29	19	10
61	TB3(2)	11 + 38	15 R	935.0	3.5 - 5.0	Sandy Loam	A-4(0)	12	100	16	44	27	13	29	20	9
61	TB3(7)	"	"	"	24.0 - 25.0	Silty Clay Loam	A-4(5)	17	60	0	11	61	28	24	16	8
61	TB3(9)	"	"	"	33.5 - 34.5	Clay Loam	A-4(3)	38	100	14	28	38	20	26	16	10
62	TB4(8)	12 + 17	15 L	934.5	28.5 - 29.4	Sand	A-2-4(0)	16	100	5	77	<-18-->		NP	NP	NP

Appendix A-10 Borehole Data for SR 3 in New Castle in Henry County (54).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
63	TB1(1)	35 + 40	65 R	972.0	3.5 - 4.0	Clay Loam	A-4(0)	5	25	0.4	37.6	38.2	13.6	NP	NP	NP
63	TB1(2)	"	"	"	8.0 - 8.5	Sandy Loam w/some gravel	A-2-4(0)	4	100	21.2	56.4	16.1	4.0	NP	NP	NP
64	B2(BAG)	39 + 95	46 L	972.7	0.0 - 3.0	Loam	A-6(4)	-	-	13.7	34.8	33.1	10.7	35.7	23.4	12.3

Appendix A-11 Borehole Data for SR 109 over Six Mile Creek in Henry County (57).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
65	B1(BAG)	332 + 13	18 L	996.7	1.0 - 2.5	Clay Loam	A-4(4)	-	-	3	32	36	29	29	19	10
65	B1(7)	"	"	"	23.5 - 25.0	Clay Loam	A-4(0)	20	90	6	30	38	26	20	16	4
66	B2(2)	332 + 43	15 R	996.2	3.5 - 5.0	Gravelly Sand	A-1-b(0)	6	80	31	64	<--5-->		NP	NP	NP
67	B3(2)	332 + 75	24 L	988.9	3.5 - 5.0	Clay Loam	A-4(1)	3	100	0	36	40	24	21	16	5
68	B4(4)	333 + 07	18 R	995.3	8.5 - 10.0	Loam	A-4(0)	3	100	10	38	32	20	21	18	3

Appendix A-12 Borehole Data for SR 103 over Little Blue River in Henry County (58).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
69	TB1(BAG)	104 + 41	16 L	1000.8	3.5 - 5.0	Clay Loam	A-6(5)	-	-	4	39	28	29	30	17	13
69	TB1(5)	"	"	"	13.5 - 15.0	Sandy Loam	A-4(0)	21	80	8	48	33	11	21	16	5
69	TB1(7)	"	"	"	23.5 - 25.0	Loam	A-4(3)	22	100	3	36	42	19	23	13	10
70	TB2(4)	104 + 88	18 R	986.2	8.5 - 10.0	Sandy Gravel	A-1-a(0)	39	70	59	37	<--4-->		NP	NP	NP
70	TB2(8)	"	"	"	28.5 - 30.0	Sand	A-2-4(0)	55	80	17	63	<-20-->		NP	NP	NP
71	TB3(8)	105 + 18	30 L	989.5	28.5 - 30.0	Clay Loam	A-4(2)	48	100	3	30	47	20	21	14	7

Appendix A-13 Borehole Data for CR 600S over Big Blue River in Henry County (60).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description		Blow per Ft.	Recovery %	Grain Size Distribution				LL	PL	PI
						Texture	AASHTO			Gravel %	Sand %	Silt %	Clay %			
72	RB2(BAG)	8 + 00	CL	920.0	1.0 - 2.5	Clay	A-7-6(10)	-	-	15	27	27	31	46	25	21
73	TB3(3)	11 + 85	13 L	911.5	6.0 - 7.5	Sandy Gravel	A-1-b(0)	40	80	47	40	<-13-->		NP	NP	NP
74	TB4(3)	12 + 43	8 R	920.0	6.0 - 7.5	Sandy Loam	A-4(0)	8	100	0	52	42	6	NP	NP	NP

Appendix A-14 Borehole Data for CR 1000S over Flatrock River in Henry County (62).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
75	RB1(BAG)	23 + 39	25 R	1018.3	1.0 - 2.5	Silty Clay Loam	A-6(14)	-	-	0	17	53	30	40	23	17
76	TB1(2)	19 + 25	6 L	1028.9	3.5 - 5.0	Silty Loam	A-4(2)	10	100	4	22	56	18	27	22	5
76	TB1(6)	"	"	"	18.5 - 20.0	Sandy Gravel	A-1-a(0)	23	100	65	34	<--1-->		NP	NP	NP
76	TB1(7)	"	"	"	23.5 - 25.0	Loam	A-4(1)	28	100	10	31	42	17	21	14	7
77	TB3(7)	20 + 25	15 L	1012.4	23.5 - 25.0	Sand	A-1-b(0)	55	75	0	96	<--4-->		NP	NP	NP

Appendix A-15 Borehole Data for CR 600S over Flat Rock River in Henry County (64).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
78	RB1(BAG)	12 + 00	5 R	1039.9	1.0 - 2.5	Sandy Loam	A-4(2)	-	-	11	41	33	15	37	27	10
79	TB1(4)	12 + 77	14 R	1039.5	8.5 - 10.0	Gravelly Sand	A-1-a(0)	38	80	48	49	<--3-->		NP	NP	NP
79	TB1(8)	"	"	"	28.5 - 30.0	Loam	A-4(0)	30	100	15	30	40	15	21	15	6
80	TB4(2)	13 + 92	14 L	1040.5	4.0 - 5.0	Gravelly Sand	A-1-a(0)	41	50	46	42	<-12-->		NP	NP	NP

Appendix A-16 Borehole Data for SR 3 in Henry County (49).

Boring #	Sample #	Station #	Offset Ft.	Ground Elevation Ft.	Sample Depth Ft.	Soil Description: Texture	Soil Description: AASHTO	Blow per Ft.	Recovery %	Grain Size Distribution: Gravel %	Sand %	Silt %	Clay %	LL	PL	PI
81	RB2(2)	14 + 50	43 L	975.0	3.0 - 5.0	Loam	A-6(5)	6	100	9	28	44	19	33	22	11
82	RB4(2)	20 + 50	53 L	968.1	4.0 - 5.0	Sand & Gravel	A-1-a(0)	17	100	50	42	<--8-->		NP	NP	NP
83	RB7(2)	58 + 97	50 R	981.0	3.5 - 5.0	Sandy Loam	A-6(2)	8	70	7	45	35	13	28	16	12
84	RB8(3)	59 + 11	42 L	979.0	6.0 - 7.5	Sand & Gravel	A-1-b(0)	58	100	41	46	<-13-->		NP	NP	NP
85	RBB(Bag)	69 + 50	60 L	1012.0	3.5 - 5.0	Sandy Clay Loam	A-6(3)	-	-	3	49	27	21	28	15	13
86	RB10(4)	70 + 25	113 L	1037.4	8.5 - 9.5	Sand	A-3(0)	36	90	14	79	<--7-->		NP	NP	NP
86	RB10(5)	"	"	"	13.5 - 15.0	Sandy Loam	A-4(0)	20	100	12	37	38	13	19	14	5
87	RB12(1)	84 + 00	47 R	1017.1	1.0 - 2.5	Sandy Loam	A-4(0)	8	60	22	41	27	10	18	13	5
88	TB2(3)	49 + 44	41 L	974.8	6.6 - 7.5	Organic Sandy Loam	A-8	12	100	0	61	29	10	63	60	3

Appendix B

Statistical Streamflow Data for a

Selected Stream in Henry County(14).

WABASH RIVER BASIN

03351400 SUGAR CREEK NEAR MIDDLETOWN, IN

LOCATION.--Lat 40°02'27", long 85°31'30", in NW¼SE¼ sec.5, T.18 N., R.9 E., Henry County, Hydrologic Unit 05120201, on right bank 90 ft upstream from bridge on County Road 750 North, 1 mi southeast of Middletown.

DRAINAGE AREA.--5.80 mi^2.

PERIOD OF RECORD.--October 1968 to September 1985.

GAGE.--Water-stage recorder. Datum of gage is 950.00 ft above National Geodetic Vertical Datum of 1929.

AVERAGE DISCHARGE.--17 years, 5.83 ft^3/s, 13.65 in/yr.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 1,100 ft^3/s April 28, 1975, gage height, 7.72 ft; minimum daily, 0.02 ft^3/s Aug. 30 to Sept. 2, 1972.

DURATION TABLE OF DAILY MEAN DISCHARGES FOR YEAR ENDING SEPTEMBER 30

NUMBER OF DAYS IN CLASS

CLASS / YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1969						2	12	2	3	23	13	18	18	18	17	25	54	43	24	22	6	15	9	10	10	4	3	3	3	2	1				
1970						2	5	23	23	13	23	26	36	23	22	9	26	17	20	32	18	11	14	8	5	3	2	2	1						
1971					9	7	14	38	39	25	36	31	31	18	16	13	11	5	8	14	12	9	6	8	5	3	3			3					
1972		4	7	11	11		1	3	27	14	29	30	14	16	21	18	21	21	28	17	20	9	11	9	7	7	3	4	1	2					
1973							5	1	20	9	8	10	17	23	32	12	24	18	21	24	28	20	30	18	15	13	7	6	2	1	1				
1974							1	15	12	26	24	18	18	7	21	16	24	29	29	29	17	14	16	9	11	5	7	6	6	3	2				2
1975			1			7	10	3	32	31	31	19	27	1	12	15	33	17	23	13	21	11	10	10	6	5	6	2	8	2	2				
1976					8	12	18	32	37	30	30	24	22	19	19	13	13	16	12	10	10	5	10	9	4	2	6		2	2	1				
1977			6	8	31	33	36	44	33	18	11	10	14	16	15	9	17	13	11	11	9	7	3	3	1	4		1	1						
1978											15	21	46	55	37	32	20	22	17	22	13	21	7	4	14	11	1	3		2	1			1	
1979											3	7	4	23	46	49	50	38	32	26	18	16	9	9	11	10	3	6	2		1	2			
1980										16	24	14	12	22	38	32	50	29	23	23	21	12	15	9	8	8	2	6	1		1				
1981								19	32	28	30	24	17	15	32	24	26	26	20	19	16	11	5	6	7	2	1	3		1					
1982							23	5	16	18	10	7	20	44	27	22	28	23	25	27	19	8	11	3	8	8	5	4	2	1		1			
1983					12	18	37	27	6	14	17	11	17	31	29	17	32	19	24	12	9	6	9	7	4	2	1	2	1		1				
1984					3			32	33	20	11	10	19	33	21	13	14	20	29	24	21	8	13	14	12	5	6	1	4						
1985						1	8	25	23	24	8	4	21	44	36	15	23	29	25	16	9	11	13	11	4	7	1	4		2		2			

CLASS	VALUE	TOTAL	ACCUM	PERCT
0	0.00	0	6209	100.00
1	0.02	4	6209	100.00
2	0.03	14	6205	99.94
3	0.04	19	6191	99.71
4	0.05	74	5172	99.40
5	0.07	82	6098	98.21
6	0.09	170	5016	96.89
7	0.12	274	5846	94.15
8	0.16	336	5572	89.74
9	0.22	309	5236	84.33
10	0.30	323	4927	79.35
11	0.41	284	4604	74.15
12	0.55	353	4320	69.58
13	0.74	408	3967	63.89
14	1.0	441	3559	57.32
15	1.4	334	3118	50.22
16	1.8	466	2784	44.84
17	2.5	386	2318	37.33
18	3.3	371	1932	31.12
19	4.5	341	1561	25.14
20	6.1	266	1220	19.65
21	8.2	194	954	15.36
22	11.0	192	760	12.24
23	15.0	147	568	9.15
24	20.0	133	421	6.78
25	27.0	99	288	4.64
26	37.0	62	189	3.04
27	50.0	53	127	2.05
28	67.0	34	74	1.19
29	91.0	21	40	0.64
30	120.0	11	19	0.31
31	170.0	5	8	0.13
32	220.0	0	3	0.05
33	300.0	1	3	0.05
34	410.0	2	2	0.03

VALUE EXCEEDED 'P' PERCENT OF TIME

P95 = 0.11
P90 = 0.16
P75 = 0.29
P70 = 0.54
P50 = 1.4
P25 = 4.5
P10 = 13.9

WABASH RIVER BASIN

03351400 SUGAR CREEK NEAR MIDDLETOWN, IN--Continued

LOWEST MEAN DISCHARGE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1	3	7	14	30	60	90	120	183
1970	0.27 13	0.30 13	0.36 13	0.41 13	0.53 13	1.40 15	1.40 14	3.30 15	3.40 14
1971	0.05 5	0.05 5	0.06 5	0.08 5	0.10 4	0.12 4	0.13 3	0.14 2	0.22 2
1972	0.08 7	0.10 8	0.11 9	0.11 8	0.18 11	0.37 11	0.46 10	0.52 9	1.80 10
1973	0.02 1	0.02 1	0.02 1	0.03 1	0.04 1	0.14 5	0.22 6	0.43 8	1.30 8
1974	0.10 9	0.10 9	0.10 8	0.13 9	0.15 8	0.17 7	0.23 7	0.63 12	2.00 12
1975	0.18 12	0.18 12	0.20 12	0.23 12	0.28 12	0.29 12	0.46 11	0.53 10	1.90 11
1976	0.03 2	0.07 6	0.08 6	0.09 6	0.11 6	0.16 6	0.17 4	0.21 3	0.30 3
1977	0.03 3	0.03 2	0.04 2	0.05 3	0.06 2	0.08 1	0.10 1	0.11 1	0.11 1
1978	0.03 4	0.03 3	0.04 3	0.04 2	0.17 10	0.26 10	0.49 12	0.60 11	1.40 9
1979	0.30 14	0.33 14	0.39 14	0.44 14	0.57 14	1.10 13	1.40 15	3.10 14	3.50 15
1980	0.72 16	0.83 16	0.86 16	1.00 16	1.19 16	1.70 16	2.70 16	5.30 16	5.50 16
1981	0.12 10	0.13 10	0.13 10	0.14 10	0.16 9	0.24 9	0.27 9	0.27 4	0.63 5
1982	0.50 15	0.52 15	0.55 15	0.56 15	0.67 15	1.10 14	1.19 13	1.40 13	3.10 13
1983	0.09 8	0.09 7	0.09 7	0.10 7	0.10 5	0.11 3	0.18 5	0.29 5	0.61 4
1984	0.05 5	0.05 4	0.05 4	0.06 4	0.07 3	0.09 2	0.12 2	0.30 6	1.19 7
1985	0.13 11	0.13 11	0.13 11	0.14 11	0.15 7	0.18 8	0.23 8	0.36 7	0.89 6

HIGHEST MEAN DISCHARGE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	183
1969	123.00 8	88.00 6	50.00 7	37.00 6	26.00 8	15.00 8	11.00 9	11.00 9	10.00 7
1970	73.00 17	43.00 16	25.00 16	15.00 16	11.00 16	11.00 13	10.00 13	8.20 14	7.20 13
1971	96.00 14	57.00 15	49.00 8	31.00 9	20.00 10	11.00 14	9.10 15	7.90 15	6.60 15
1972	110.00 12	86.00 7	46.00 9	29.00 10	20.00 11	14.00 11	11.00 10	10.00 10	10.00 8
1973	122.00 9	72.00 11	41.00 13	36.00 7	27.00 7	19.00 6	15.00 6	14.00 4	15.00 2
1974	135.00 7	97.00 4	62.00 5	47.00 5	30.00 3	22.00 3	20.00 2	19.00 2	14.00 3
1975	443.00 1	198.00 1	107.00 1	59.00 1	38.00 1	28.00 1	26.00 1	25.00 1	19.00 1
1976	122.00 10	69.00 12	37.00 14	27.00 11	22.00 9	15.00 9	11.00 11	8.80 12	7.90 12
1977	79.00 16	39.00 17	20.00 17	12.00 17	7.20 17	6.70 17	5.70 17	5.50 17	3.80 17
1978	303.00 2	149.00 3	79.00 3	51.00 2	31.00 2	20.00 4	16.00 5	12.00 6	9.80 10
1979	179.00 5	89.00 5	79.00 4	49.00 3	29.00 4	17.00 7	13.00 7	11.00 7	12.00 4
1980	167.00 6	74.00 10	44.00 11	24.00 14	15.00 15	11.00 15	10.00 12	9.90 11	8.50 11
1981	110.00 13	64.00 13	42.00 12	25.00 12	17.00 14	11.00 16	9.70 14	8.70 13	5.90 14
1982	208.00 3	82.00 8	51.00 6	33.00 8	28.00 6	24.00 2	19.00 3	16.00 3	11.00 5
1983	121.00 11	82.00 9	45.00 10	24.00 15	18.00 12	12.00 12	8.60 16	7.20 16	5.30 16
1984	87.00 15	61.00 14	34.00 15	25.00 13	17.00 13	14.00 10	13.00 8	11.00 8	10.00 9
1985	204.00 4	158.00 2	85.00 2	48.00 4	29.00 5	20.00 5	16.00 4	13.00 5	11.00 6

ANNUAL VALUES

ANNUAL MEAN DISCHARGE AND RANKING IN YEAR ENDING MARCH 31

1970	6.40 11
1971	3.30 4
1972	4.50 5
1973	8.60 15
1974	8.00 12
1975	9.60 16
1976	5.90 7
1977	2.20 2
1978	5.10 6
1979	6.10 8
1980	8.20 13
1981	2.70 3
1982	8.40 14
1983	2.00 1
1984	6.30 10
1985	6.10 9

ANNUAL MEAN DISCHARGE AND RANKING IN YEAR ENDING SEPTEMBER 30

1969	6.50 5
1970	4.10 13
1971	3.50 15
1972	5.30 11
1973	8.80 2
1974	8.70 3
1975	9.50 1
1976	4.30 12
1977	2.00 17
1978	6.50 6
1979	7.30 4
1980	6.10 7
1981	3.80 14
1982	6.10 8
1983	3.30 16
1984	5.70 9
1985	5.70 10

WABASH RIVER BASIN

03351400 SUGAR CREEK NEAR MIDDLETOWN, IN--Continued

NORMAL MONTHLY MEANS (ALL DAYS)

YEAR	OCT	NOV	DEC	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT
1969	0.17	0.98	4.14	16.20	10.00	2.32	11.10	2.96	14.00	6.18	4.82	1.58
1970	2.04	7.07	3.60	3.23	7.69	10.40	10.60	1.78	2.23	0.43	0.17	0.14
1971	0.10	0.16	0.37	1.56	17.40	6.15	0.69	6.79	8.16	0.59	0.18	0.86
1972	0.68	0.52	17.30	7.88	2.58	7.40	19.90	4.79	1.29	0.38	0.17	0.44
1973	1.01	22.90	14.10	7.80	6.41	24.00	12.90	1.44	9.93	2.92	1.62	0.18
1974	0.17	3.29	14.40	25.30	8.24	15.20	12.80	4.75	13.10	5.69	0.42	0.91
1975	0.29	0.52	6.44	22.00	34.00	16.10	27.40	6.56	2.06	0.23	0.36	0.12
1976	0.21	0.22	1.94	10.90	15.40	6.66	0.83	4.48	3.54	7.61	0.17	0.08
1977	0.12	0.14	0.13	0.06	4.05	5.21	6.08	6.11	0.57	0.17	0.95	0.79
1978	4.66	1.43	11.20	1.07	0.81	26.20	10.40	8.67	1.80	1.08	8.46	1.58
1979	3.64	4.46	6.77	4.79	10.80	11.20	8.82	1.90	5.78	17.60	15.60	1.57
1980	1.80	14.10	8.13	4.45	4.55	14.00	5.47	3.81	12.70	0.74	2.72	0.32
1981	0.28	0.35	0.30	0.19	3.91	1.93	4.53	16.50	3.01	9.02	3.87	1.40
1982	1.49	1.34	4.34	19.00	18.00	18.60	4.87	1.71	3.71	0.41	0.67	0.11
1983	0.11	0.43	5.05	1.79	3.49	2.24	9.77	12.30	2.87	1.81	0.12	0.07
1984	0.54	8.51	12.70	1.37	10.80	14.50	13.90	4.32	1.04	0.38	0.17	0.29
1985	0.68	3.17	9.40	5.09	23.30	12.40	7.74	5.50	1.53	0.30	0.23	0.21

	OCT	NOV	DEC	JAN	FEB	MARCH
TWENTY FIFTH PERCENTILE	0.17	0.39	2.77	1.46	3.98	5.68
FIFTIETH PERCENTILE	0.54	1.34	6.44	4.79	8.24	11.20
SEVENTY FIFTH PERCENTILE	1.64	5.76	12.00	14.50	16.39	15.60

	APRIL	MAY	JUNE	JULY	AUG	SEPT
TWENTY FIFTH PERCENTILE	5.17	2.43	1.66	0.38	0.17	0.13
FIFTIETH PERCENTILE	9.77	4.75	3.01	0.74	0.42	0.32
SEVENTY FIFTH PERCENTILE	12.90	6.67	9.04	6.65	3.29	1.15

WABASH RIVER BASIN

03351400 SUGAR CREEK NEAR MIDDLETOWN, IN--Continued

LOWEST MEAN DISCHARGE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1	3	7	14	30	60	90	120	183
1970	0.27 13	0.30 13	0.36 13	0.41 13	0.53 13	1.40 15	1.40 14	3.00 15	3.40 14
1971	0.05 6	0.05 5	0.06 5	0.08 5	0.10 4	0.12 4	0.13 3	0.14 2	0.22 2
1972	0.08 7	0.10 3	0.11 9	0.11 8	0.18 11	0.37 11	0.46 10	0.52 9	1.30 10
1973	0.02 1	0.02 1	0.02 1	0.03 1	0.04 1	0.14 5	0.22 6	0.43 8	1.30 8
1974	0.10 9	0.10 9	0.10 8	0.13 9	0.15 3	0.17 7	0.23 7	0.63 12	2.00 12
1975	0.18 12	0.18 12	0.20 12	0.23 12	0.28 12	0.39 12	0.46 11	0.53 10	1.30 11
1976	0.03 2	0.07 6	0.08 5	0.09 6	0.11 5	0.16 6	0.17 4	0.21 3	0.30 3
1977	0.03 3	0.03 2	0.04 2	0.05 3	0.06 2	0.08 1	0.10 1	0.11 1	0.11 1
1978	0.03 4	0.03 3	0.04 3	0.04 2	0.17 10	0.26 10	0.49 12	0.60 11	1.40 9
1979	0.20 14	0.23 14	0.29 14	0.44 14	0.57 14	1.10 13	1.40 15	3.10 14	3.50 15
1980	0.72 16	0.83 16	0.86 16	1.00 16	1.19 16	1.70 16	2.70 16	5.30 16	5.50 16
1981	0.12 10	0.13 10	0.13 10	0.14 10	0.16 9	0.24 9	0.27 9	0.27 4	0.63 5
1982	0.50 15	0.52 15	0.55 15	0.56 15	0.67 15	1.10 14	1.19 13	1.40 13	3.10 13
1983	0.09 8	0.09 7	0.09 7	0.10 7	0.10 5	0.11 3	0.18 5	0.29 5	0.61 4
1984	0.05 5	0.05 4	0.05 4	0.06 4	0.07 3	0.09 2	0.12 2	0.30 6	1.19 7
1985	0.13 11	0.13 11	0.13 11	0.14 11	0.15 7	0.18 8	0.23 8	0.26 7	0.89 6

HIGHEST MEAN DISCHARGE AND RANKING FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1	3	7	15	30	60	90	120	183
1969	123.00 8	88.00 6	50.00 7	37.00 6	26.00 8	15.00 3	11.00 9	11.00 9	10.00 7
1970	73.00 17	43.00 16	25.00 16	15.00 16	11.00 16	11.00 13	10.00 13	8.20 14	7.20 13
1971	96.00 14	57.00 15	49.00 8	31.00 9	20.00 10	11.00 14	9.10 15	7.90 15	5.60 15
1972	110.00 12	86.00 7	46.00 9	29.00 10	20.00 11	14.00 11	11.00 10	10.00 10	10.00 8
1973	122.00 9	72.00 11	41.00 13	36.00 7	27.00 7	19.00 6	15.00 6	14.00 4	15.00 2
1974	135.00 7	97.00 4	62.00 5	47.00 5	30.00 3	22.00 3	20.00 2	19.00 2	14.00 3
1975	443.00 1	198.00 1	107.00 1	59.00 1	38.00 1	28.00 1	26.00 1	25.00 1	19.00 1
1976	122.00 10	69.00 12	37.00 14	27.00 11	22.00 9	15.00 9	11.00 11	8.80 12	7.90 12
1977	79.00 16	39.00 17	20.00 17	12.00 17	7.20 17	6.70 17	5.70 17	5.50 17	3.80 17
1978	303.00 2	149.00 3	79.00 3	51.00 2	31.00 2	20.00 4	16.00 5	12.00 6	9.80 10
1979	179.00 5	89.00 5	79.00 4	49.00 3	29.00 4	17.00 7	13.00 7	11.00 7	12.00 4
1980	167.00 6	74.00 10	44.00 11	24.00 14	15.00 15	11.00 15	10.00 12	9.90 11	8.50 11
1981	110.00 13	64.00 13	42.00 12	25.00 12	17.00 14	11.00 16	9.70 14	8.70 13	6.90 14
1982	208.00 3	82.00 8	51.00 6	33.00 8	28.00 6	24.00 2	19.00 3	16.00 3	11.00 5
1983	121.00 11	82.00 9	45.00 10	24.00 15	18.00 12	12.00 12	8.60 16	7.20 16	5.30 16
1984	87.00 15	61.00 14	34.00 15	25.00 13	17.00 13	14.00 10	13.00 8	11.00 8	10.00 9
1985	204.00 4	158.00 2	85.00 2	48.00 4	29.00 5	20.00 5	16.00 4	13.00 5	11.00 6

ANNUAL VALUES

ANNUAL MEAN DISCHARGE AND RANKING IN YEAR ENDING MARCH 31

1970	6.40 11
1971	3.30 4
1972	4.50 5
1973	8.60 15
1974	8.00 12
1975	9.60 16
1976	5.90 7
1977	2.20 2
1978	5.10 6
1979	6.10 8
1980	8.20 13
1981	2.70 3
1982	8.40 14
1983	2.00 1
1984	6.30 10
1985	6.10 9

ANNUAL MEAN DISCHARGE AND RANKING IN YEAR ENDING SEPTEMBER 30

1969	6.50 5
1970	4.10 13
1971	3.50 15
1972	5.30 11
1973	8.80 2
1974	8.70 3
1975	9.50 1
1976	4.30 12
1977	2.00 17
1978	6.50 6
1979	7.80 4
1980	6.10 7
1981	3.80 14
1982	6.10 8
1983	3.30 16
1984	5.70 9
1985	5.70 10

Appendix C

Engineering, Physical, and Chemical

Properties of Soils (1).

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
CeB2---------------- Celina	0-9	Silt loam--------	ML	A-4	0	100	90-100	90-100	70-85	25-40	3-10
	9-32	Clay, clay loam, silty clay loam.	CL	A-6, A-7	0	100	90-100	80-95	70-85	32-48	12-28
	32-60	Loam, silt loam	CL, CL-ML	A-4, A-6	0	75-95	75-90	65-90	50-80	20-36	4-16
CeC2---------------- Celina	0-7	Silt loam--------	ML	A-4	0	100	90-100	90-100	70-85	26-40	3-10
	7-34	Clay, clay loam, silty clay loam.	CL	A-6, A-7	0	100	90-100	80-95	70-85	32-48	12-28
	34-60	Loam, silt loam	CL, CL-ML	A-4, A-6	0	75-95	75-90	65-90	50-80	20-36	4-15
CrA---------------- Crosby	0-11	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	90-100	50-90	15-30	4-15
	11-33	Clay loam, silty clay loam, clay.	CL	A-6, A-7	0-3	90-100	85-100	75-95	65-95	35-50	15-35
	33-60	Loam------------	CL, ML, CL-ML	A-4, A-6	0-3	85-100	80-95	75-90	50-95	15-30	4-15
CsA---------------- Crosby	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	95-100	85-100	65-90	20-35	5-15
	9-26	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	95-100	90-100	80-95	35-45	15-30
	26-60	Loam------------	CL-ML, CL	A-4, A-6	0-10	85-95	80-90	65-90	50-70	20-35	5-15
Cy---------------- Cyclone	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	20-45	12-25
	12-46	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-50	15-30
	46-50	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	85-100	80-95	50-80	25-40	4-15
	50-80	Loam------------	CL-ML, CL	A-4, A-6	0	90-100	85-100	75-95	50-75	20-30	5-15
EdA, EdB2, EdC2, EdD2, EdE2------ Eldean	0-10	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	85-100	80-100	70-100	55-90	20-40	4-14
	10-26	Clay, sandy clay, gravelly clay loam.	CL, ML	A-7, A-6	0-5	75-100	60-100	55-95	50-80	38-50	12-23
	26-31	Gravelly clay loam, loam, gravelly sandy loam.	CL, GC, SC	A-4, A-6, A-7, A-2	0-10	55-85	45-85	45-75	30-60	30-45	8-20
	31-60	Stratified sand to gravel.	GM, SM, GP-GM, SP-SM	A-1, A-2	0-15	30-70	20-60	5-40	0-35	---	NP
ExC3, ExD3------- Eldean	0-5	Clay loam--------	CL	A-6, A-4	0-5	85-100	75-100	65-100	55-80	25-40	9-18
	5-32	Clay, sandy clay, gravelly clay loam.	CL, ML	A-7, A-6	0-5	75-100	60-100	55-95	50-80	38-50	12-23
	32-60	Stratified sand to gravel.	GM, SM, GP-GM, SP-SM	A-1, A-2	0-15	20-70	20-60	5-40	0-35	---	NP
Ge---------------- Genesee	0-17	Loam------------	ML, CL	A-4, A-6	0	100	100	90-100	75-90	26-40	3-15
	17-37	Silt loam, loam	ML, CL	A-4, A-6	0	100	100	90-100	75-90	26-40	3-15
	37-60	Stratified sandy loam to silt loam.	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	60-90	50-90	20-35	3-15
La---------------- Landes	0-23	Loam------------	CL, CL-ML	A-4, A-6	0	100	90-100	85-95	50-75	20-35	5-15
	23-60	Stratified sand to silt loam.	SM, SP-SM, SC, SM-SC	A-2, A-4	0	100	85-100	70-95	10-50	30	NP-10
LeB2, LeC2, LeD2, LeE2------------ Losantville	0-7	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	95-100	90-100	80-100	65-90	20-30	5-12
	7-16	Clay, clay loam	CL	A-7, A-6	0-2	90-100	85-100	75-95	60-90	35-50	15-25
	16-60	Loam------------	CL, CL-ML	A-4	0-5	85-95	80-95	65-85	50-70	20-30	5-10

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
LhC3, LhD3-------- Losantville	0-4	Clay loam---------	CL	A-6	0-2	95-100	90-100	80-100	65-80	30-40	11-20
	4-13	Clay, clay loam	CL	A-7, A-6	0-2	90-100	85-100	75-95	60-90	35-50	15-25
	13-60	Loam-------------	CL, CL-ML	A-4	0-5	85-95	80-95	65-85	50-70	20-30	5-10
LsB2, LsC2, LsD2, LsE2------------ Losantville	0-5	Silt loam---------	CL, CL-ML	A-4, A-6	0-2	95-100	90-100	80-100	65-90	20-30	5-12
	5-20	Clay, clay loam	CL	A-7, A-6	0-2	90-100	85-100	75-95	60-90	35-50	15-25
	20-60	Loam-------------	CL, CL-ML	A-4	0-5	85-95	80-95	65-85	50-70	20-30	5-10
LxC3, LxD3-------- Losantville	0-4	Clay loam---------	CL	A-6	0-2	95-100	90-100	80-100	65-80	30-40	11-20
	4-12	Clay, clay loam	CL	A-7, A-6	0-2	90-100	85-100	75-95	60-90	35-50	15-25
	12-60	Loam-------------	CL, CL-ML	A-4	0-5	85-95	80-95	65-85	50-70	20-30	5-10
Ma--------------- Martisco	0-15	Sapric material	PT	A-8	0	---	---	---	---	---	---
	15-27	Marl-------------	---	---	0	---	---	---	---	---	---
	27-60	Stratified gravelly sandy loam to silty clay loam.	CL, SC	A-4, A-6	0	65-100	40-90	30-80	20-70	15-25	4-15
MlA, MlB2-------- Miami	0-15	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	95-100	85-100	70-90	20-30	6-15
	15-39	Silty clay loam, clay loam.	CL	A-6	0	100	90-100	80-100	65-95	30-40	10-20
	39-60	Loam, silt loam	CL-ML, CL	A-4, A-6	0	100	90-100	75-100	55-85	20-35	5-15
MmB2------------- Miamian	0-9	Silt loam---------	ML	A-4, A-6	0	95-100	95-100	90-100	70-95	26-40	4-12
	9-32	Silty clay loam, clay loam, clay.	CL	A-6, A-7	0-5	85-100	80-100	75-95	70-85	32-50	15-30
	32-60	Loam, silt loam	CL, ML, CL-ML	A-4, A-6	0-5	75-95	75-90	65-85	50-75	20-35	3-13
MoB2------------- Miamian	0-7	Silt loam---------	ML	A-4, A-6	0	95-100	95-100	90-100	70-95	26-40	4-12
	7-34	Silty clay loam, clay loam, clay.	CL	A-6, A-7	0-5	85-100	80-100	75-95	70-85	32-50	15-30
	34-60	Loam, silt loam	CL, ML, CL-ML	A-4, A-6	0-5	75-95	75-90	65-85	50-75	20-35	3-13
Mx--------------- Millgrove	0-12	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	85-100	80-100	70-100	55-85	20-40	3-16
	12-36	Clay loam, sandy clay loam, loam.	CL, SC	A-6	0	85-100	80-100	70-95	40-75	25-40	11-26
	36-60	Gravelly loam, very gravelly sandy loam, gravelly clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6, A-2, A-1	0-5	60-100	35-85	25-80	15-60	25-40	4-15
Ot*: Orthents.											
Aquents.											
Pt*. Pits											
Sg--------------- Shoals	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0	100	100	90-100	65-90	20-35	6-15
	8-43	Silt loam, loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-85	25-40	5-15
	43-60	Stratified silt loam to loamy sand.	ML, CL, CL-ML	A-4	0-3	90-100	80-100	50-80	40-70	<30	4-10

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Sk---------------- Sleeth	0-13	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	90-100	75-95	50-85	20-35	3-15
	13-42	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	85-95	85-95	80-90	65-75	30-40	15-25
	42-46	Gravelly clay loam, gravelly sandy clay loam, gravelly loam.	CL	A-6	0-3	65-95	50-85	55-70	50-70	30-40	15-25
	46-60	Stratified sand to gravelly sand.	SP, GP, SP-SM, GP-GM	A-1	1-5	30-70	22-65	7-30	2-10	---	NP
Sn---------------- Sloan	0-12	Silty clay loam	CL	A-6, A-7	0	100	95-100	85-100	70-95	35-45	12-20
	12-32	Silty clay loam, clay loam, silt loam.	CL, ML	A-6, A-7, A-4	0	100	90-100	85-100	75-95	30-45	8-18
	32-60	Stratified gravelly sandy loam to silty clay loam.	ML, CL	A-4, A-6	0	95-100	70-100	60-95	50-90	25-40	3-15
Ts---------------- Treaty	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-95	25-40	5-15
	8-35	Silty clay loam	CL	A-6	0	100	100	95-100	85-95	30-40	10-15
	35-51	Clay loam, silty clay loam, loam.	CL, CL-ML	A-6, A-4	0	95-100	90-100	75-95	55-85	25-40	5-15
	51-60	Loam, silt loam	CL-ML, CL	A-4, A-6	0	90-100	90-95	75-90	55-75	20-30	5-15
Wb---------------- Washtenaw	0-8	Silt loam--------	ML, CL	A-4, A-6	0	100	100	90-100	70-90	27-36	4-12
	8-20	Silt loam, loam	CL, ML	A-6, A-4	0	100	100	90-100	70-90	27-36	4-12
	20-50	Silty clay loam, clay loam.	CL	A-6, A-7	0	95-100	95-100	90-100	75-95	36-50	15-28
	50-60	Loam--------------	CL	A-4, A-6	0-3	90-100	85-95	80-95	60-75	22-33	8-15
We---------------- Westland	0-10	Silt loam--------	CL	A-6	0	95-100	90-100	85-95	65-75	27-38	11-20
	10-30	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	80-90	65-75	35-50	15-30
	30-45	Gravelly clay loam, gravelly sandy loam.	CL	A-6, A-7	0-5	55-75	60-70	55-70	50-70	30-50	15-30
	45-60	Stratified sand to gravelly sand.	SP, GP, SP-SM, GP-GM	A-1	1-5	30-70	22-65	7-30	2-10	---	NP

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
CeB2	0-9	14-26	1.30-1.50	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	3	6	1-3
Celina	9-32	35-48	1.45-1.70	0.2-0.6	0.15-0.19	4.5-7.3	Moderate	0.37			
	32-60	15-27	1.60-1.82	0.2-0.6	0.06-0.10	7.4-8.4	Low	0.37			
CeC2	0-7	14-26	1.30-1.50	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	3	6	1-3
Celina	7-34	35-48	1.45-1.70	0.2-0.6	0.15-0.19	4.5-7.3	Moderate	0.37			
	34-60	16-27	1.60-1.82	0.2-0.6	0.06-0.10	7.4-8.4	Low	0.37			
CrA	0-11	11-24	1.35-1.45	0.6-2.0	0.20-0.24	5.1-7.3	Low	0.43	3	5	1-3
Crosby	11-23	25-45	1.50-1.70	0.06-0.2	0.15-0.20	5.1-7.3	Moderate	0.43			
	23-60	15-27	1.70-2.00	0.06-0.6	0.05-0.17	7.4-8.4	Low	0.43			
CsA	0-9	15-24	1.40-1.55	0.6-2.0	0.19-0.22	5.1-7.3	Low	0.37	3	5	1-3
Crosby	9-26	35-40	1.45-1.60	0.06-0.2	0.16-0.17	5.1-7.3	Moderate	0.37			
	26-60	15-27	1.70-2.00	0.06-0.2	0.05-0.15	7.4-8.4	Low	0.37			
Cy	0-12	27-33	1.40-1.50	0.6-2.0	0.22-0.24	6.1-7.3	Low	0.28	5	7	4-5
Cyclone	12-46	27-35	1.40-1.60	0.6-2.0	0.18-0.20	6.1-7.3	Moderate	0.43			
	46-60	15-30	1.40-1.60	0.6-2.0	0.15-0.19	6.6-7.3	Low	0.43			
	60-80	15-25	1.50-1.80	0.2-0.6	0.05-0.19	7.4-8.4	Low	0.43			
EdA, EdB2, EdC2, EdD2, EdE2	0-10	15-25	1.30-1.50	0.6-2.0	0.18-0.22	5.6-7.3	Low	0.37	4	5	1-3
Eldean	10-26	35-48	1.40-1.60	0.2-2.0	0.08-0.14	5.6-7.3	Moderate	0.37			
	26-31	25-45	1.20-1.60	0.6-2.0	0.07-0.14	6.6-8.4	Low	0.37			
	31-60	2-8	1.35-1.70	>6.0	0.01-0.04	7.4-8.4	Low	0.10			
ExC3, ExD3	0-5	27-33	1.35-1.55	0.6-2.0	0.16-0.18	5.6-7.3	Low	0.37	3	6	.5-3
Eldean	5-32	35-48	1.40-1.60	0.2-2.0	0.08-0.14	5.6-7.3	Moderate	0.37			
	32-60	2-8	1.35-1.70	>6.0	0.01-0.04	7.4-8.4	Low	0.10			
Ge	0-17	18-27	1.20-1.50	0.6-2.0	0.20-0.24	6.1-7.3	Low	0.37	5	5	1-3
Genesee	17-37	18-27	1.30-1.50	0.6-2.0	0.17-0.22	6.1-8.4	Low	0.37			
	37-60	10-20	1.30-1.50	0.6-2.0	0.19-0.21	7.4-8.4	Low	0.37			
La	0-23	10-22	1.20-1.40	0.6-2.0	0.20-0.22	6.1-8.4	Low	0.28	5	5	3-7
Landes	23-60	5-22	1.50-1.80	6.0-20	0.05-0.15	6.1-8.4	Low	0.20			
LeB2, LeC2, LeD2, LeE2	0-7	18-27	1.30-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	3	6	1-3
Losantville	7-16	35-45	1.40-1.70	0.2-2.0	0.09-0.19	6.1-7.3	Moderate	0.37			
	16-60	12-24	1.50-1.80	0.06-0.2	0.05-0.19	7.4-8.4	Low	0.37			
LhC3, LhD3	0-4	27-35	1.30-1.60	0.2-0.6	0.17-0.19	5.6-7.3	Moderate	0.37	2	6	.5-3
Losantville	4-13	35-45	1.40-1.70	0.2-2.0	0.09-0.19	6.1-7.3	Moderate	0.37			
	13-60	12-24	1.50-1.80	0.06-0.2	0.05-0.19	7.4-8.4	Low	0.37			
LsB2, LsC2, LsD2, LsE2	0-6	18-27	1.20-1.55	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	3	6	.5-3
Losantville	6-20	35-45	1.40-1.70	0.2-2.0	0.09-0.19	6.1-7.3	Moderate	0.37			
	20-60	12-24	1.50-1.80	0.06-0.2	0.05-0.19	7.4-8.4	Low	0.37			
LxC3, LxD3	0-4	27-35	1.20-1.60	0.2-0.6	0.17-0.19	5.6-7.3	Moderate	0.37	2	6	.5-2
Losantville	4-12	35-45	1.40-1.70	0.2-2.0	0.09-0.19	6.1-7.3	Moderate	0.37			
	12-60	12-24	1.50-1.80	0.06-0.2	0.05-0.19	7.4-8.4	Low	0.37			
Ma	0-15	---	0.13-0.23	0.6-6.0	0.35-0.45	6.1-8.4	---	---	---	2	25-75
Martisco	15-27	---	---	0.06-0.2	---	7.9-8.4	Low	---			
	27-60	18-30	1.50-1.80	2.0-6.0	0.07-0.12	7.9-8.4	Low	0.17			

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
MlA, MlB2 Miami	0-15	18-25	1.30-1.45	0.6-2.0	0.22-0.24	6.1-7.3	Low	0.37	5	5	1-3
	15-39	27-35	1.35-1.45	0.6-2.0	0.18-0.21	5.6-6.5	Moderate	0.37			
	29-60	18-27	1.40-1.60	0.6-2.0	0.16-0.20	7.4-7.8	Low	0.37			
MmB2 Miamian	0-9	14-27	1.30-1.50	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	5	5	1-3
	9-32	35-48	1.45-1.70	0.2-0.6	0.12-0.18	4.5-7.3	Moderate	0.27			
	32-60	16-31	1.60-1.82	0.2-0.6	0.06-0.10	7.4-8.4	Low	0.37			
MoB2 Miamian	0-7	14-27	1.30-1.50	0.6-2.0	0.20-0.24	5.6-7.3	Low	0.37	5	5	1-3
	7-34	35-48	1.45-1.70	0.2-0.6	0.12-0.18	4.5-7.3	Moderate	0.37			
	34-60	16-31	1.60-1.82	0.2-0.6	0.06-0.10	7.4-8.4	Low	0.37			
Mx Millgrove	0-12	18-27	1.30-1.50	0.6-2.0	0.19-0.24	5.6-7.3	Low	0.28	5	6	3-8
	12-36	18-35	1.40-1.70	0.6-2.0	0.12-0.16	6.1-7.3	Moderate	0.28			
	36-60	15-30	1.25-1.60	0.6-2.0	0.08-0.15	6.1-7.8	Low	0.28			
Ot*: Orthents.											
Aquents.											
Pt*. Pits											
Sq Shoals	0-8	18-27	1.20-1.30	0.6-2.0	0.22-0.24	6.1-7.8	Low	0.37	5	5	2-5
	8-43	18-33	1.25-1.55	0.6-2.0	0.17-0.22	6.1-7.8	Low	0.37			
	43-60	12-25	1.35-1.60	0.6-2.0	0.12-0.21	6.6-8.4	Low	0.37			
Sk Sleeth	0-13	12-22	1.30-1.45	0.6-2.0	0.20-0.24	6.6-7.3	Low	0.32	5	5	.5-3
	13-42	20-35	1.45-1.60	0.6-2.0	0.15-0.19	5.6-6.5	Moderate	0.32			
	42-46	20-35	1.40-1.60	0.6-2.0	0.14-0.16	6.6-8.4	Moderate	0.32			
	46-60	2-6	1.50-1.80	>20	0.02-0.04	7.9-8.4	Low	0.10			
Sn Sloan	0-13	27-33	1.25-1.30	0.6-2.0	0.18-0.22	6.1-7.3	Moderate	0.37	5	6	3-6
	13-32	22-35	1.25-1.55	0.2-2.0	0.15-0.19	6.1-8.4	Moderate	0.37			
	32-60	10-30	1.20-1.50	0.2-2.0	0.13-0.18	6.6-8.4	Low	0.37			
Ts Treaty	0-8	18-27	1.30-1.70	0.6-2.0	0.23-0.25	5.6-7.3	Low	0.32	5	6	4-6
	8-25	28-35	1.30-1.70	0.6-2.0	0.18-0.20	6.1-7.3	Moderate	0.43			
	25-51	20-35	1.30-1.70	0.6-2.0	0.15-0.19	6.6-7.3	Moderate	0.43			
	51-60	15-27	1.70-1.80	0.2-0.6	0.17-0.19	7.4-8.4	Low	0.43			
Wb Washtenaw	0-8	15-27	1.30-1.45	0.6-2.0	0.22-0.24	6.1-7.3	Low	0.37	5	5	2-7
	8-20	15-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.37			
	20-50	28-35	1.40-1.60	0.06-0.2	0.15-0.20	6.1-7.3	Moderate	0.37			
	50-60	15-25	1.45-1.65	0.06-0.2	0.05-0.19	7.4-8.4	Moderate	0.37			
We Westland	0-10	18-27	1.30-1.45	0.6-2.0	0.18-0.22	5.6-7.3	Moderate	0.28	5	6	2-6
	10-30	27-35	1.45-1.60	0.6-2.0	0.15-0.19	5.6-7.3	Moderate	0.28			
	30-45	25-30	1.40-1.60	0.6-2.0	0.14-0.16	5.6-7.3	Moderate	0.28			
	45-60	1-7	1.30-1.75	>20	0.02-0.04	7.4-8.4	Low	0.10			

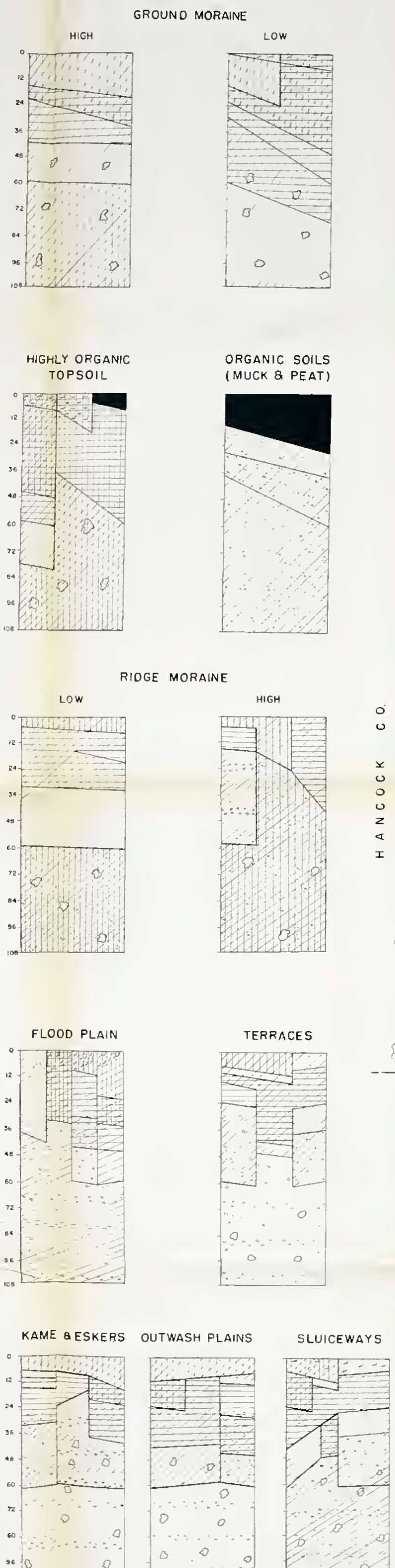
Appendix D

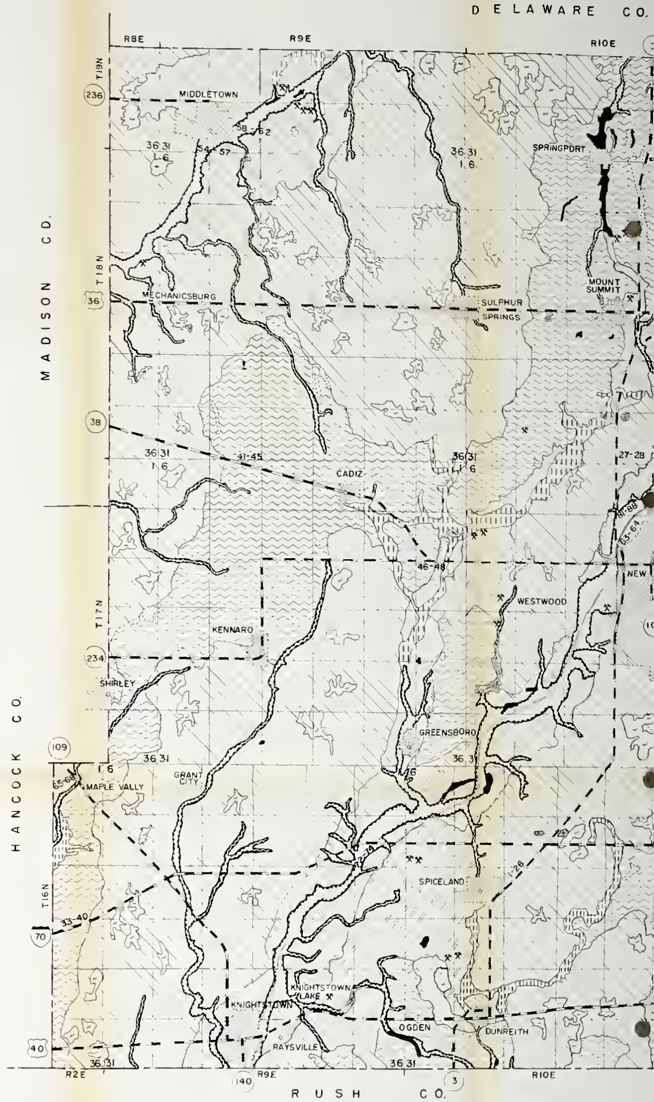
Soil and Water Properties of Soils (1).

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
CeB2, CfB2-------- Celina	C	None--------	---	---	2.0-3.5	Perched	Jan-Apr	>60	---	High-----	High-----	Moderate.
CrA, CsA---------- Crosby	C	None--------	---	---	1.0-3.0	Perched	Jan-Apr	>60	---	High-----	High-----	Moderate.
Cy---------------- Cyclone	B/D	None--------	---	---	+.5-1.0	Apparent	Dec-May	>60	---	High-----	High-----	Low.
EdA, EdB2, EdC2, EdD2, EdE2, ExC3, ExD3------------- Eldean	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Ge---------------- Genesee	B	Occasional	Brief-----	Oct-Jun	>6.0	---	---	>60	---	Moderate	Low-------	Low.
La---------------- Landes	B	Rare--------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
LeB2, LeC2, LeD2, LeE2, LhC3, LhD3, LsB2, LsC2, LsD2, LsE2, LxC3, LxD3- Losantville	C	None--------	---	---	4.0-6.0	Perched	Jan-Apr	>60	---	Moderate	Moderate	Moderate.
Ma---------------- Martisco	B/D	None--------	---	---	+1-0.5	Apparent	Oct-Jun	>60	---	High-----	High-----	Low.
MlA, MlB2--------- Miami	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
MmB2, MoB2-------- Miamian	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Mx---------------- Millgrove	B/D	None--------	---	---	+1-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
Ot*: Orthents.												
Aquents.												
Pt*. Pits												
Sg---------------- Shoals	C	Occasional	Brief-----	Oct-Jun	0.5-1.5	Apparent	Jan-Apr	>60	---	High-----	High-----	Low.
Sk---------------- Sleeth	C	None--------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	High-----	High-----	Low.
Sn---------------- Sloan	B/D	Occasional	Brief-----	Nov-Jun	0-1.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
Ts---------------- Treaty	B/D	None--------	---	---	+.5-1.0	Apparent	Dec-May	>60	---	High-----	High-----	Low.
Wb---------------- Washtenaw	C/D	None--------	---	---	+.5-1.0	Apparent	Dec-May	>60	---	High-----	High-----	Low.
We---------------- Westland	B/D	None--------	---	---	+.5-1.0	Apparent	Dec-May	>60	---	High-----	High-----	Low.

JHRP 90/3

GENERAL SOIL PROFILES





ENGINEERING S

HENRY C

INDIAN

PREPA D F

1940 AERIAL PHO

BY

JOINT HIGHWAY RESEA

AT

PURDUE UNIV

1990

SCALE OF MIL

PREPARED UNDER THE SUPERVISION OF B SCHMIDT, R D MILES, AND C W LOVELL

LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- GROUND MORAINE
- OUTWASH PLAIN
- FLOOD PLAIN
- RIDGE MORAINE
- TERRACE
- ESKER AND KAME
- SLUICEWAY

- HIGHLY ORGANIC TOPSOIL
- GRAVEL PIT
- BORING SITES
- MUCK
- LAKE OR POND
- URBAN AREAS

TEXTURAL SYMBOLS FOR SOIL PROFILES

- LOAM
- SILT
- HIGHLY ORGANIC TOPSOIL
- CLAY
- GRAVEL
- COBBLE OR BOULDER
- SAND
- PEAT AND MUCK

ENGINEERING SOILS MAP
HENRY COUNTY
INDIANA

PREPARED FROM
1940 AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT
AT
PURDUE UNIVERSITY
1990

SCALE OF MILES

DRAWN BY MEI ZHANG

COVER DESIGN BY ALDO GIORGINI